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CIVIL ENGINEERING RESEARCH

ANALYZING, EVALUATING,
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THERMAL ENERGY
CONTRIBUTIONS OF THE
PASSIVE SOLAR-HEATING
ELEMENTS INCORPORATED IN
THE DESIGN AND
CONSTRUCTION OF THE
PLUMBLEE RESIDENCE
LOCATED IN ALAMANCE
COUNTY, NC

Presented By

Mark A. Terrell Graduate Student

Under the Direction of

Dr. Michael L. Leming Associate Professor, Construction Engineering & Management

August 2004

Approved for Public Release
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DEPARTMENT OF CIVIL ENGINEERING NORTH CAROLINA STATE UNIVERSITY

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ANALYZING, EVALUATING, AND QUANTIFYING THE THERMAL ENERGY CONTRIBUTIONS OF THE PASSIVE SOLAR-HEATING ELEMENTS INCORPORATED IN THE DESIGN AND CONSTRUCTION OF THE PLUMBLEE RESIDENCE LOCATED IN ALAMANCE COUNTY, NC

Presented By

Mark A. Terrell Graduate Student

Under the Direction of

Dr. Michael L. Leming Associate Professor, Construction Engineering & Management

North Carolina State University

Department of Civil, Construction, and Environmental Engineering
Raleigh, NC

August 2004

ABSTRACT

Currently, nationwide efforts are being made to help policymakers, construction professionals and consumers become more aware of the benefits of incorporating sustainable energy principles in residential building design and construction (Miller 1996). Any success in applying these principles is the result of effective communication by design professionals to builders and homeowners in understanding cost benefit tradeoffs for using sustainable energies in homes. The Gordon and Janice Plumblee Residence, located on 1742 Routh Road in Burlington, NC, is an example of how passive solar-heating design elements, along with simple conventional construction techniques, have created a comfortable, affordable, and low-energy consumption home.

This report evaluates the passive solar and energy conservative elements incorporated in the Plumblee Home and quantifies the significance of each element energy contribution. A model of the thermal performance of the home is compared to the actual performance. The accuracy of the model is verified. The modeling software is used to perform a sensitivity study of the thermal performance. An analysis of the construction methods and materials used is presented.

ACKNOWLEDGMENTS

Sincere appreciation is extended to homeowner, Mr. Gordon Plumblee for his permission to use his home in this study. Mr. Plumblee, a former high school biology instructor, provided critical data on monthly electricity usage for his home over a period of eight years along with other information relating to the operational aspects of the home. Sincere gratitude is also extended to Dr. Herbert M. Eckerlin, PE and Professor of Mechanical & Aerospace Engineering for the technical review and assistance in analyzing the thermal performance of the home. Significant gratitude is also given to Mr. Rex S. Terrell, Contractor of Record, for providing construction details and cost estimates.

Special thanks are extended to Ms. Debra R. Coleman, AIA of Sun Plans Inc., Architect of Record, for the recommendation of which software program to use for modeling the home and to Ms. Dona Stankus, AIA of NC Solar Center for providing a copy of the software for the study.

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1. Introduction

Passive solar-heating elements used in residential home design and construction offer significant benefits in advancing to more sustainable energy usage nationwide. Capturing the free heat directly from the sun in a controlled environment of a passive solar home makes solar energy economically and environmentally more attractive (Chiras 2002). In addition, the natural sunlight brought in from large, south-facing windows brightens the interior. Passive solar features that utilize the benefits of sunlight aid in lower energy consumption of other nonrenewable energy sources and provide natural lighting as a delightful comfort for home occupants (Rucker 1992).

Passive solar design is based upon understanding the principles of heat transfer through various building surfaces. Residential homes experience heat gains or losses through elements such as windows, doors or chimneys, and through ceilings, walls, floors, and air infiltration. Determining whether the heat transfer is either a loss or a gain is a function of the seasonal changes in the motion of the earth around the sun. For the earth's northern hemisphere, the sun track is higher in the sky during the summer (cooling season) and lower during the winter (heating season). The seasonal location of the sun, combined with the construction details of the home, affect how much heat loss or solar gain is experienced. Designers understanding heat transfer concepts can incorporate passive solar-heating principles in the design of any style home (Chiras 2002).

The case study home in this report is the residence of Gordon and Janice Plumblee located in Alamance County, NC. The Plumblee Home is a "direct gain" passive solar home. This means that the house collects, stores, and distributes the solar heat throughout the house.

1.1. Professional Guidelines for Passive Solar Homes

Passive solar design applies energy-saving techniques using conventional design and construction practices as incorporated in the Plumblee Home. Debra Coleman, Architect for the Plumblee Home, prescribed the following passive solar design factors for creating a comfortable, low-energy consuming home (Rucker 1992):

1. Home orientation, shape, and floor plan.

The floor plan is oriented with the elongation in the east-west direction allowing the long exterior walls to face north and south. Heat generating rooms such as the kitchen and laundry are located on the colder northern side. Living areas intended for more frequent use share the common south-facing wall. A rectangular configuration without projections from the south wall is preferred in order to place south-facing windows to receive winter sun. Any protrusion to the south will shade adjacent windows (Rucker 1992).

2. Window placement and shading.

Passive solar homes benefit from receiving sunlight. The maximum recommended south-facing window area is 12% of the floor area. North, east, and west windows should not exceed 4% of the floor area (Chiras 2002). Special attention is required for designing roof overhangs including gutters. Overhang lengths without gutters vary from 3.5 feet in hot climates to only 12 inches for colder climates. The south eaves will shade the windows from high summer sun but allow low winter sun to penetrate deep into the home (Rucker 1993). Professional consultation is advised for specific situations.

3. Heat-absorbing materials.

In order to moderate inside temperature changes and to prevent overheating of the home, thermal masses or heat-absorbing materials are utilized to collect or store heat from solar gains. Brick chimneys or concrete floors covered with stone, decorative tile, or brick pavers serve as heat-absorbing thermal mass adding additional comfort and aesthetics to the home.

4. Insulation and air infiltration control.

No additional insulation is required above current regulations. Prior to insulating all building-envelope surfaces, joints are carefully caulked around exterior walls and intersecting floors and ceilings. Exterior walls and ceiling receive a continuous vapor barrier sealed from any penetration or tear. Doors, windows, electrical boxes, and pipe penetrations are sealed and foamed around. Energy-efficient windows and inner doors separating entryways and main living spaces are recommended. These extra precautions minimize air infiltration (Rucker 1992).

5. Mechanical system.

Passive solar homes require less heating because of south-glazing solar gains in the winter and less cooling due to overhang shading in the summer. A heating, ventilation, and air-conditioning (HVAC) system complementing these passive solar features is essential (Chiras 2002). Again, professional consultation is advised for specific situations.

Quality control of construction methods and materials.

Respect and understanding of energy-efficient design and concepts is necessary during the construction phase of a passive solar home. A comfortable, low-energy home is only achieved by abiding to the details provided in blueprints and energy-efficient specifications (Rucker 1992).

1.2. Limitations of Passive Solar Design

Optimal performance and desired comfort are best achieved when the basic principles of passive solar design are applied under professional supervision. The ratio of south-facing

windows to thermal storage mass directly affects the overall thermal performance of the home. The auxiliary heating system may require additional runtime during the winter if the amount of south-facing windows is less than optimal. Otherwise, undersized thermal mass can cause daytime overheating. Although some remediation can be performed after construction, the basic shape, cross-sectional construction, and orientation of the home cannot easily be changed later. Therefore, having the home's insulation details, air infiltration control, and major axis oriented east-west are essential fundamentals for an effective passive solar home (Chiras 2002).

1.3. Description of Plumblee Home



Figure 1 - Southeast View of Plumblee Residence (photo by Gordon Plumblee)

The Plumblee Home located in central North Carolina is secluded by surrounding farmland and natural landscaping overlooking a private lake. The exterior façade is cypress beveled siding covered on the north and east sides by a wrap-around porch. This single-story home has an

abundance of south-facing windows with brick veneer covering the foundation and southwest corner along with the northwest garage wall.

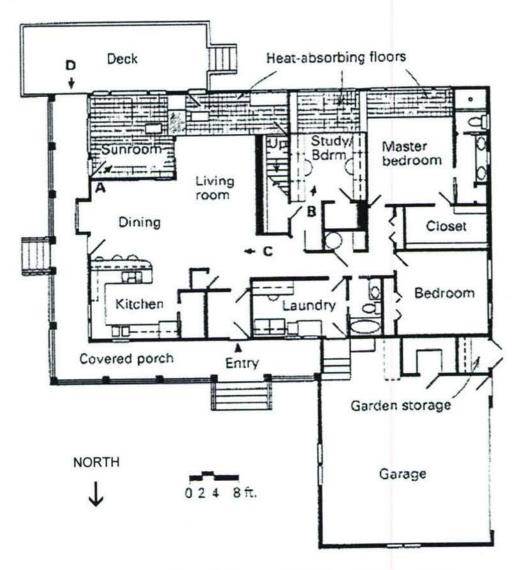


Figure 2 – Floor Plan of Plumblee Residence (Rucker 1993)

The 2160 square-feet home has its major axis oriented east-west to make the long south-facing wall available to the sun. Interior features include vaulted ceilings over kitchen and living space, hardwood floors, French doors, brick hearth, and brick pavers on the floor adjacent to the south-facing windows providing natural sunlight. The living room, study, master bedroom, and sunroom share the common south-facing exterior wall allowing the home occupants to

experience the view and desirable comfort provided by the windows. The kitchen, laundry, and other heat generating rooms are located on the colder northern side.

1.4. Design and Construction Professionals Involved

The successful completion and high energy-efficient performance of the Plumblee Home is a direct result of effective communication and comprehensive understanding of the design details and construction aspects by all parties involved in the building of the home. Debra R. Coleman, AIA provided the design documents and drawings based on the homeowner's desired characteristics. Harry Boody, PE of Guaranteed Energy Efficient Systems, Inc. was responsible for the insulation, caulking, vapor barrier, and mechanical system installation. Rex S. Terrell, a homebuilder from Burlington, NC, provided the quality construction supervision, adhering to the energy-conserving and comfort details desired by the homeowner (Rucker 1992).

1.5. Overview of Energy-10 Software

Energy-10 is a creditable software analysis program for conceptual design of energy-efficient buildings produced by the U.S. Department of Energy (DOE) at the National Renewable Energy Laboratory (NREL). The program allows professional solar designers to predict the energy performance of a small-size facility to achieve optimal comfort, performance, and economy (Chiras 2002).

The selection of using Energy-10 was recommended by Ms. Debra R. Coleman, AIA of Sun Plans Inc. Ms. Coleman, knowing the popularity of the software among passive solar designers, felt the thermal simulation analysis by Energy-10 would provide insight in the effects of passive solar and energy conservative features incorporated in the Plumblee Home.

2. Research Significance

The various passive solar features of the Plumblee Home have created a comfortable, low-energy use home (corresponding with the homeowner). The contributions of the various thermal energy features built into the home have not been fully quantified. This report provides an important addition to the body of knowledge of passive solar home performance and will be of significant value to the engineer, architect, planning commissions and other parties implementing effective passive solar and energy efficient home design. Unique, long term operating data on the energy consumption of the Plumblee Home is available from the homeowner. The completeness of this data makes the home an ideal candidate for further detailed analysis. Little information exists in the published literature which provides quantitative estimates of the effects of passive solar and energy conservative features incorporated into residential dwellings.

2.1. Research Objectives

- 1. Analyze and evaluate the actual thermal performance of the Plumblee Home.
- Model the predicted thermal performance with a creditable energy efficiency software program for sustainable buildings.
- Compare the actual thermal performance with the modeled thermal performance and verify
 the software output for general conformance.
- Evaluate and quantify the thermal energy contributions of the various passive solar and energy conservative elements in the Plumblee Home.
- Identify the effect of the various passive solar energy conservative elements in terms of cost savings.
- 6. Identify ways to improve the thermal performance of the Plumblee Home.

3. Methods Used for Resolution

In order to quantify the impact of each feature, the actual total thermal energy use was compared with the total projected use simulated in the software modeling program. The various solar and energy conservative features were then incorporated into the model to determine their effect to the overall house performance. The thermal energy contribution of each feature was ranked and evaluated.

The following procedures established the database used in this study:

- 1. Gather and classify information to establish the database.
 - a. Collect actual energy use records from the homeowner and develop graphical representations suitable for analysis.
 - b. Collect historical weather and climatologic data from the National Oceanic and Atmospheric Administration (NOAA) for Burlington, NC.
- Select a creditable software analysis program which can simulate the thermal performance of a passive solar and energy conservative home.
- 3. Verify accuracy of the software modeling program for general conformance with actual data.
 - a. Model and estimate the projected annual thermal energy performance of the passive solar home using the software program.
 - b. Compare the actual annual energy use with the modeled annual energy use projected by the software program.
 - c. Verify that the modeled performance is acceptable as a reasonable projection of annual energy use for the Plumblee Home.
- 4. Use the software modeling program to conduct sensitivity analyses of the thermal performance of the home.

a. Vary different passive solar and energy conservative features using the software program to quantify the significance of each element incorporated in the Plumblee Home.

4. Thermal Performance Derivations

The objective of obtaining a detailed energy use analysis of the Plumblee Home involves collecting the actual energy use consumed annually and modeling the projected annual energy use. The meticulous records kept by Mr. Gordon Plumblee, have provided critical information for modeling the thermal performance efficiency of the home. Monthly meter readings from separate meters for the total house electrical load and the HVAC system load were recorded by Mr. Plumblee for the first eight years of operation. Thus, the actual thermal performance was determined by simply separating the heating and cooling loads from the total house load.

However, modeling the thermal performance is not simple. Thermal performance modeling requires information on specific details of the home, as well as the living style of the home occupants, for input into the selected energy performance design software, Energy-10.

4.1. Summary of Data Entry for Energy-10

The Plumblee Home is a single-story dwelling of two occupants with 2160 square-feet of conditioned living space and 768 square-feet of unconditioned garage and storage. The home is heated and cooled with a heat pump based on an average electricity rate of \$0.069 per kilowatt-hour of usage for the period of 1991 to 1994. All climatology and weather data used in Energy-10 for this analysis is from historical data reported in Greensboro, NC, the nearest reporting weather station to the actual home site in Burlington, NC.

The home is oriented with the main surface area of glazing due south. The south-facing windows account for 206 square-feet of glazing bordered by cypress trim-siding. The north and east exterior walls are constructed with the standard 2 x 4 stud frames, R-13 batt-insulation, and polyisocyanurate foam board. A covered porch finished with cypress siding also extends along the north and east façade. The western portion of the exterior including the garage is covered with brick veneer. The north, east and west glazing areas are 33, 79, and 25 square-feet respectively.

Roof construction for the home consists of trusses with attic storage space. R-30 batt-insulation is over the western portion of the home and R-30 blown-in insulation over the cathedral ceilings of the living room, dining room, and kitchen. The overhangs have 17 inches of eaves with a 4 inch gutter to provide adequate summer shading for this passive solar home. The covered porch extends 6 feet from the main house along the north entrance and east side of the house.

Floor construction is framed over a crawlspace block foundation. Basic floor construction is hardwood finish over plywood sub-flooring framed with 2x10 joists at 16 inches on-center spacing and R-19 batt-insulation. The laundry room and bathrooms are vinyl floors. Brick pavers cover 360 square-feet of floor space adjacent to the south-facing windows serving as thermal storage mass (along with the brick chimney and hearth). The floor construction under the brick pavers consists of 4 inches of concrete over 2x12 joists at 12 inches on-center spacing and R-19 batt-insulation.

The heat pump has a high coefficient of performance (COP) of 3.02 and a low COP of 2.14 for the heating season, with a seasonal energy efficiency ratio (SEER) of 10.1 for the cooling season. The air-handling unit and insulated ductwork for the heat pump are located in

the crawlspace. Thermostat comfort set-points are 68 degrees-Fahrenheit for the heating season and 77 degrees-Fahrenheit for the cooling season. The total conditioned house volume accounts for 18,653 cubic-feet of living space. The average air infiltration rate for the living space is 0.22 air-changes per hour (ACH), based on the blower door tests conducted by Duke Power Company in August 1993 (Plumblee 2004).

The internal gains affecting the overall thermal performance of the home are a function of the interior and exterior lighting loads, the occupancy schedule, the hot water usage, and other electrical loads from basic operating appliances. These loads given in peak watts per square-foot, with their associated hourly profiles and schedules, are listed in Appendix A along with a more detailed review of the building construction described above.

4.2. Modeling: Energy-10 Software Program

Energy-10 was validated using the BESTEST protocol. The BESTEST procedure was developed within the International Energy Agency Solar Heating and Cooling Program, and was adopted by DOE and the international community as the accepted basis for verifying the credibility of computer simulation programs. The procedure verified the simulation results of Energy-10 for two defined hypothetical buildings, a low-mass building and a high-mass building. The simulation is considered to be credible if the given results fall within or close to the range of results obtained using other simulation programs. Thermal simulations produced by Energy-10 were reported by the developers as performing "very well" in comparison to the BESTEST standards (Energy-10, Help Topics – Version 1.5, 2002).

The thermal performance model of Energy-10 incorporates heating energy, cooling energy, heat loss, and solar gain along with the effects of added thermal mass, shading design, glazing, building orientation, and air infiltration control. Simulated results involve calculating the home's

thermal performance relative to desired indoor temperature and overall heat transfer, including both losses and gains. The amount of useful solar energy provided to the home is dependent on solar radiation as well as conduction losses, air infiltration losses, and heat gains from internal loads. The auxiliary space heating or cooling required is the amount of the load not provided by solar energy or thermal storage.

The rate of heat loss is determined by the resistance to heat flow (R-value) of various building elements for the walls, floors, ceilings, windows, doors, etc. The overall coefficient of heat transfer (U-value) is determined for each exterior building surface as the reciprocal of the sum of the R-values. The rate of conduction heat loss is the total surface area multiplied by the calculated U-value of the surface and the temperature difference. Ultimately, the total space heat loss is then the sum of the conduction losses and air infiltration losses through the various building surfaces (Mazria 1979).

Energy-10 is intended to be used during the conceptual design phase before construction documents are prepared. For this research, the actual energy performance of the Plumblee Home had already been monitored and recorded as monthly electric power usage. Therefore, the projected model desired from Energy-10 is calibrated by actual performance data. Furthermore, the modeling capability of Energy-10 allowed the contribution of each passive solar and energy conservative feature to be estimated. The individual significance of each feature was evaluated by either adding or subtracting each solar element from the input data of the model simulated in Energy-10.

4.3. Actual Performance: Meter Readings Recorded by Homeowner

The actual thermal performance of the Plumblee Home was derived from the metered electricity usage recorded monthly for the total house load and the HVAC system load. The

HVAC system load is subtracted from the total house load to provide the power usage for the auxiliary appliances, lights, and other internal gains. The power usage recorded in terms of kilowatt-hours (kWh) was converted to thermal energy use in terms of British-thermal-units (BTU) using the conversion factor of one kWh is equal to 3,415 BTU. Bar graphs of the annual energy use for the home are provided in Appendix B showing the monthly HVAC system load and total house load.

The modeled output report from Energy-10 displays the annual energy use generating a bar graph of the heating load, cooling load, lighting load, other house loads, and total load. The output is in terms of thousand British-thermal-units of energy per square-feet of conditioned living space (kBTU/ft²). In order to verify the modeled output for general conformance, the actual HVAC system load metered is divided into heating and cooling season loads for comparison to the model report. The homeowner reported that the thermostat was changed in October for the heating season and during April or May for the cooling season. Therefore, the heating season form the Plumblee Home runs from November to March and the cooling season from June to September. Climatology data from the National Climatic Data Center of the National Oceanic and Atmospheric Administration (NOAA) was retrieved online for the monthly annual heating degree days and cooling degree days and used as a guide for verifying the actual months of the heating and cooling seasons.

5. Discussion of Results

The results of the thermal analysis of the Plumblee Home, as modeled by Energy-10, correlated well with the actual thermal performance of the house. The effect of various passive solar and energy conservative measures on the performance of the home was evaluated. These measures were evaluated and ranked according to their heating contribution to the house.

5.1. Verification of Model

5.1.1. Data Evaluation and Analysis

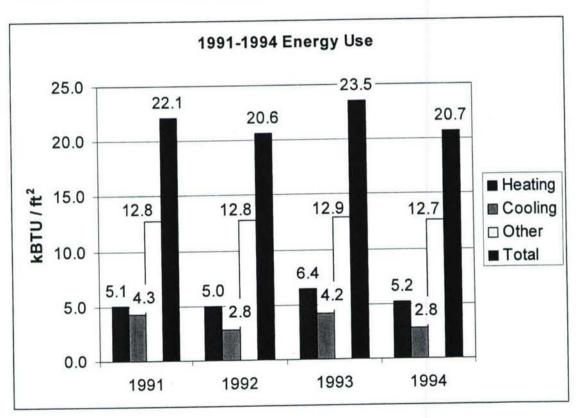


Figure 3 - Actual Energy Use of Plumblee Home

Actual operating data for the years 1991 through 1994 were selected as a basis for determining how the House actually performs. The living patterns of the Plumblees were very consistent during these years. This explains why the heating, cooling, lighting and other costs

were so consistent during the 1991 –1994 period. This fact was borne out in the very consistent energy-use data recorded for these years.

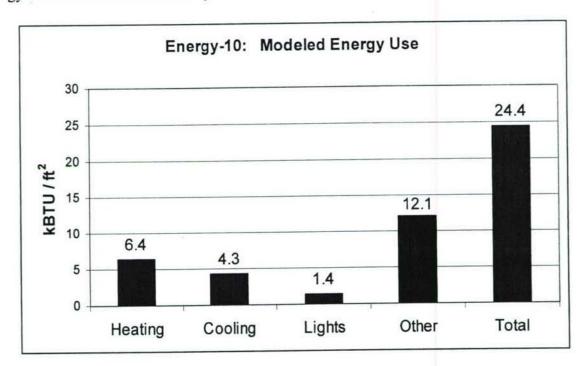


Figure 4 – Model of Energy Use (Energy-10)

Year	Heating	Cooling	Other	<u>Total</u>
1991	5.1	4.3	12.8	22.1
1992	5.0	2.8	12.8	20.6
1993	6.4	4.2	12.9	23.5
1994	5.2	2.8	12.7	20.7
Actual Average	5.4	3.5	12.8	21.7
Standard Deviation of Sample	0.68	0.80	0.10	1.39
Energy-10 Model Results	6.4	4.3	13.5	24.4
Model – Actual Avg Std Dev	1.43	0.96	6.83	1.92
% of Actual	118%	122%	106%	112%

Table 1 – Verification of Model (units = $kBTU/ft^2$)

There are three important findings from this analysis. First, the Energy 10 model predicts the actual energy use quite well. The model appears to be conservative in predicting actual energy usage and is within about 12 percent of the total house energy use. Second, the model is sufficiently accurate since the modeled energy use for heating and cooling is less than two standard deviations from the actual average energy use. For the "other" category, the correlation between the model and the actual is even better (see Table 1). Based on these results, Energy-10 was found to be an acceptable vehicle for evaluating the effectiveness of various solar and energy conservation measures on the performance of passive solar residential structures.

5.1.2. Research Limitation of Data Input Affecting Thermal Analysis

The actual date of change-over from seasonal operation of heating or cooling is unknown. Interpolations of the heating and cooling loads were calculated using the percent of heating or cooling degree days recorded in climatology data for the months of April, May, and October (NOAA). If the yearly turn-over between seasonal room temperature settings was known, then the conformance between the model and actual performance would likely be improved. Although the uncertainty exists, Energy-10 appears to be sufficiently accurate in the correlation between modeled and actual energy use.

5.2. Sensitivity Study of Passive Solar and Energy Conservative Features

5.2.1. Factors

Because of the excellent manner the Energy-10 model approximates the actual performance of the Plumblee House, it was decided that Energy-10 could effectively be used to evaluate the impact of various passive solar and energy conservation measures. The following heating performance measures were varied independently from the actual home construction to obtain predicted performance in order to identify those areas of design most critical to performance:

- House orientation rotated 15, 30, and 45 degrees east of true south.
- South-facing glazing surface area and type.
- Surface area of windows in east, west, and north walls.
- Roof-overhang lengths (including 4 inch gutter).
- Amount of thermal storage mass provided by brick pavers.
- Wall construction details; 2x4 to 2x6 exterior frames.
- Room temperature set-points.
- Air infiltration control.

5.2.2. Findings

(1) Orientation:

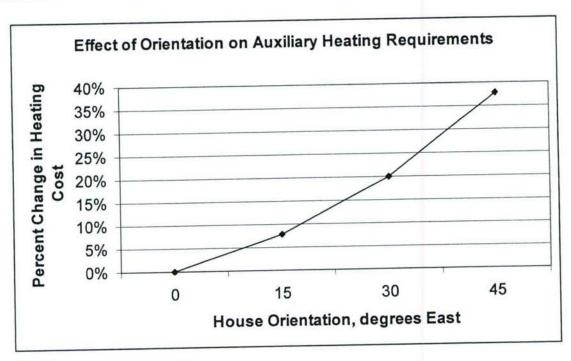


Figure 5 - Model of Orientation Effects (using Energy-10)

Additional heating is required when positioning the home orientation with the major axis in a direction other than east-west. A 15-degree east deviation from true south results into 7.3 percent of additional auxiliary heating required.

(2) Glazing:

Converting all south-facing windows from standard glass to Low-E glass provides a 6.5 percent cost savings in auxiliary heating required. Figures 6 and 7 below show the effect that increasing the south facing glazing has on (1) the "Auxiliary Heating Requirements" and (2) the "Cooling Requirements" of a house. As would be expected, an increase in glazing reduces the heating demand and increases the cooling load.

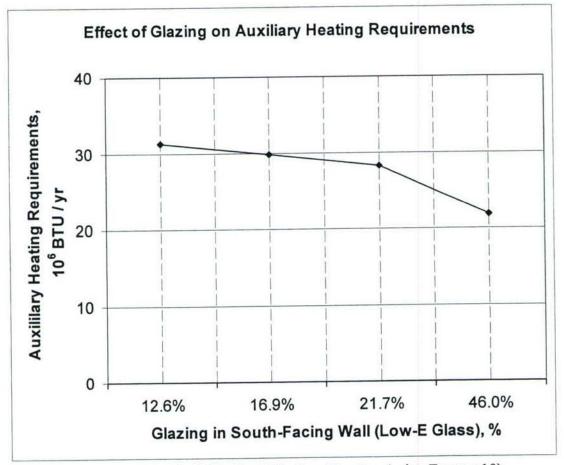


Figure 6 - Model of Glazing Effect on Heating (using Energy-10)

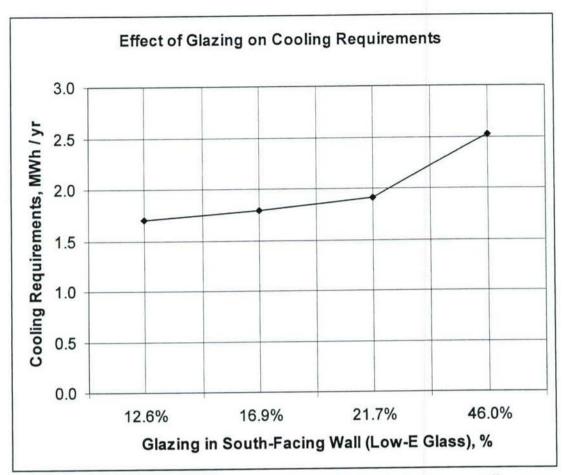


Figure 7 – Model of Glazing Effect on Cooling (using Energy-10)

(3) Roof Overhang:

The roof overhang length was varied from 24 to 12 inches of boxed eave with a 4 inch gutter.

A reduction in overall overhang extension from 28 inches to 21 inches yields a 3.7 percent cost savings in auxiliary heating required.

(4) Thermal Mass Effects:

The additional thermal storage mass provided by the brick pavers and concrete in the floor area along the south-facing wall provides 5.2 percent of cost savings in auxiliary heating requirements. Any additional thermal mass may cause overheating during adverse weather.

(5) Wall Insulation:

Wall construction was varied in the thermal simulation by changing the 2x4 frame with R-13 batt-insulation to 2x6 with R-19 for the exterior walls. A 13.5 percent cost savings in auxiliary heating requirements is obtained by using 2x6 exterior walls.

(6) Temperature Set-point:

Setting back the thermostat comfort temperature from 70 degrees-Fahrenheit to 68°F in the heating season provides a 28.3 percent cost savings in auxiliary heating required.

(7) Air Infiltration Control:

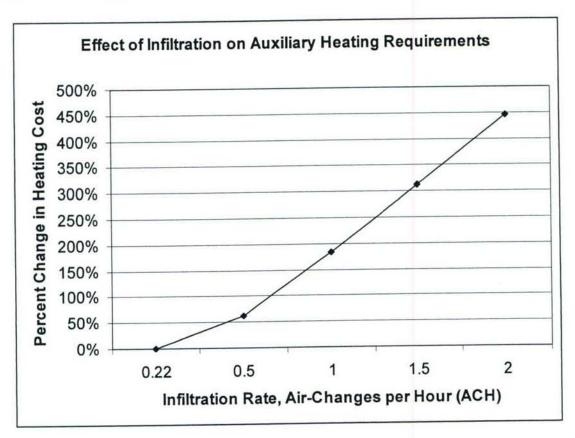


Figure 8 - Model of Air Infiltration Control (using Energy-10)

The default value of air infiltration rate commonly used in design is 1.0 air-change per hour (ACH). In this part of the study, air infiltration rates were varied from 0.5 ACH to 2.0 ACH. A cost savings of 43 percent in auxiliary heating requirements is achieved when reducing air

infiltration from 1.0 ACH to 0.5 ACH. The Plumblee Home has an average air infiltration rate of 0.22 ACH. The extra precautions of providing a continuous vapor barrier and sealing off all openings and penetrations during construction has produced a considerably effective, "air-tight" home.

5.2.3. Implications of Sensitivity Analysis of Plumblee Home

Air infiltration and room temperature control are considered to have a reasonably significant effect on the heating performance of the Plumblee Home. The amount of heat loss through the seams or cracks of windows, doors, walls, and ceilings is minimal as the result of having an "air-tight" home and a smaller temperature difference from outside to inside conditions.

Moderate changes in heating performance appear to be cost effective for changing 2x4 to 2x6 exterior wall construction and increasing the amount of Low-E glass in south-facing windows. The remaining features are considered to be marginal in the effect of heating performance and could be implemented in the "fine-tuning" of the conceptual design.

The following is a summary of the effectiveness of various passive solar and energy conservative features for improving the heating performance of the Plumblee passive solar-heated home:

	Control Measure Implemented	Percent Cost Savings
•	Make the house tighter. (i.e., reduce the infiltration from 1 ACH to 0.5 ACH)	43.0%
•	Reduce room temperature by 2°F (e.g., from 70°F to 68°F).	28.3%
•	Increase south-facing Low-E glazing by 10 percent.	15.0%
•	Change from 2x4 to 2x6 wall construction.	13.5%
•	Reduce window area in east, west and north wall by 50%.	7.7%
	Orient the house 15° more toward true south.	7.3%

6.5% Convert south-facing glazing from standard glass to low-e glass. 5.2% Increase thermal mass (brick pavers) in floor from 0% to 17%. 3.7%

Reduce roof overhang (from 28 in. to 21 in.).

Based on construction methods and material costs, the most efficient, energy conservative measures for improving heating performance in order of cost savings, are (1) controlling air infiltration by making the house tighter, (2) setting back room temperature, and (3) laying out the house in the beginning with the major axis in the east-west direction. Room temperature is controlled by the home occupants and little can be done by the professional to modify this parameter. House orientation can clearly be addressed early as part of the design cost, but lot or site constraints may limit options. The sensitivity analysis indicates that the additional time, materials, and labor for installing a vapor barrier and caulking cracks or seams around windows, doors, walls, and ceilings to minimize infiltration are clearly worthwhile and should be included in all residential construction. The sensitivity analysis suggests that the effect of air infiltration rate on energy use is sufficiently important. Changes in the building code which would result in the reduction of the air infiltration rate should be considered for all new construction. Although not included in this case study, a more thorough cost analysis of the thermal performance and energy conservative measures is recommended.

6. Conclusions and Recommendations

- Energy-10 provided a conservative model of the thermal performance of this particular passive solar-heated home and was considered to be valid for conceptual design of similar energy efficient buildings.
- Modeled thermal performance simulated by Energy-10 is a reasonably accurate projection of the actual thermal performance experienced by the Plumblee Home.
- Energy-10 appears to be sufficiently accurate in the correlation between modeled and actual
 energy use, considering the uncertainty of the actual date of change-over from seasonal
 operation of heating or cooling for the Plumblee Home is unknown.
- Energy-10 provided a reasonable prediction of the effectiveness of passive solar and energy conservative features incorporated in the Plumblee Home.
- Home orientation, window placement, insulation details, air infiltration control, room temperature setting, and quality construction are the considerably significant design factors for creating a comfortable, low-energy consuming passive solar-heated home.
- Air infiltration and room temperature control are considered to have a reasonably significant effect on the heating performance of the Plumblee Home.
- A thorough cost analysis of the thermal performance and energy conservative measures is recommended.
- Additional studies are recommended to compare other similar passive solar homes to the Plumblee Home.

REFERENCES

- Course Notes from MAE 421, "Design of Solar Heating Systems," Spring 2004. NC State University, Dr. Herbert M. Eckerlin, Professor.
- House specifications and design details provided by Gordon Plumblee, homeowner, March 2004.
- Rucker, Debra G. "A Sun-Inspired Home," The Southface Journal. Summer 1992.
 Rucker, Debra G. "A Sun Inspired Home," Carolina Sun. North Carolina Solar Energy
 Association (NCSEA), Volume 15 No. 2, Summer 1992.
- 4. Rucker, Debra G. "Practical Solar Design," Fine Homebuilding. October/November 1993.
- 5. Miller, Burke. "Passive Solar, Country-Style," Solar Today. July/August 1996.
- Chiras, Dan. "Build a Solar Home and Let the Sunshine In," Mother Earth News. August/September 2002.
 - http://www.motherearthnews.com/
- 7. Mazria, Edward. "The Passive Solar Book," Rodak Press, 1979.
- Rucker, Debra G. "Custom Residence for Barbara & Gordon Plumblee," Design Drawings.
 Energetic Design, Inc. March 1989.
- Energy-10 software program, "A Conceptual Design Tool for Energy Efficient Buildings."
 National Renewable Energy Laboratory (NREL) under the U.S. Department of Energy,
 Version 1.5 Release June 2002.
- Balcomb, J. Douglas. "Mastering Energy-10." National Renewable Energy Laboratory (NREL), July 2002.
- National Oceanic and Atmospheric Administration (NOAA), Online.
 http://www.noaa.gov/

12. National Climatic Data Center – National Environmental Satellite, Data, and Information Service, NOAA; Online.

http://www.ncdc.noaa.gov/oa/ncdc.html

APPENDICES

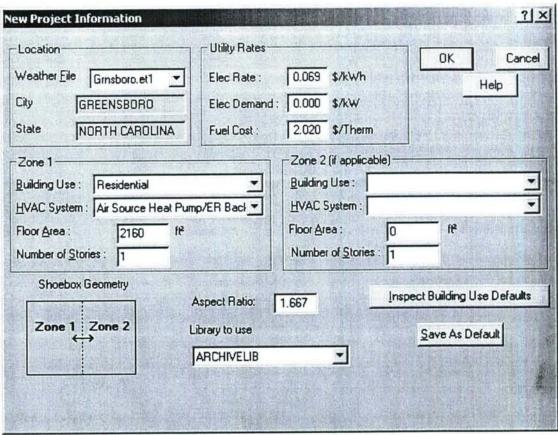
APPENDIX A

{Energy-10: Program Input}

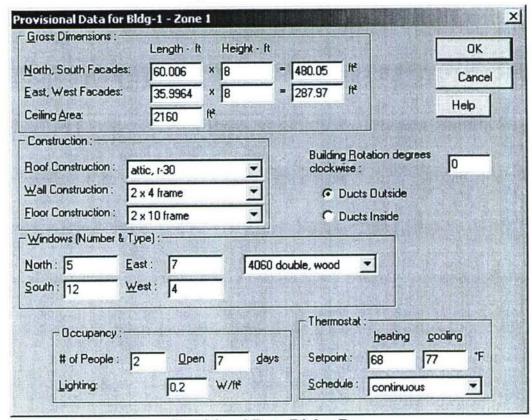
Appendix A

Energy Efficient Case

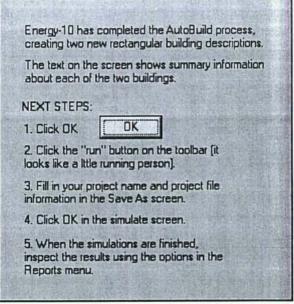
Input reflects actual construction details and conditions experienced at the Plumblee Home.



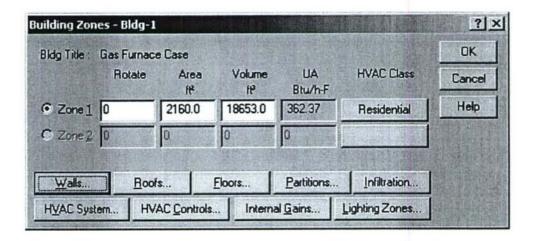
New Project Information Dialog Box



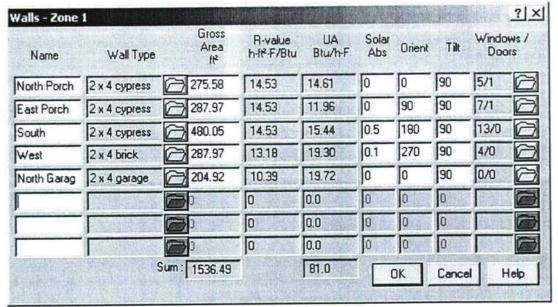
Provisional Data Dialog Box



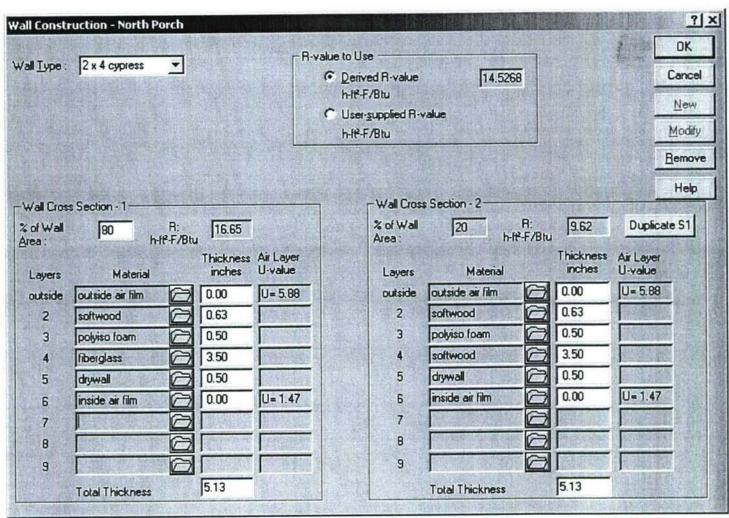
"AutoBuild" Informational Dialog Box



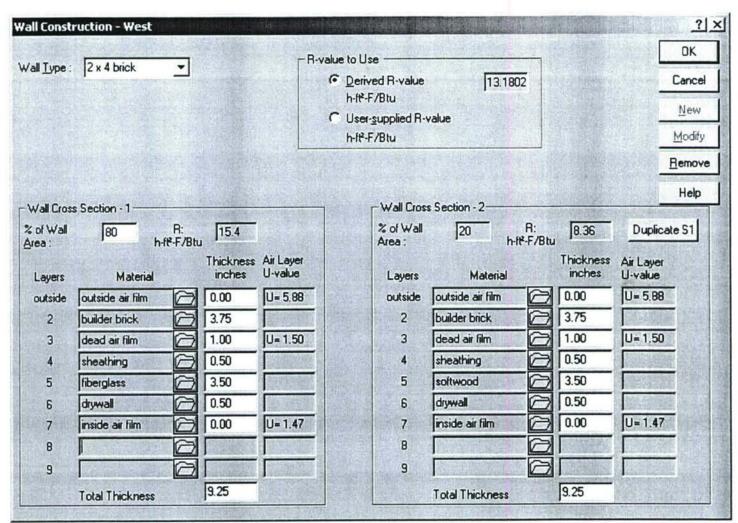
Building Zones Dialog Box



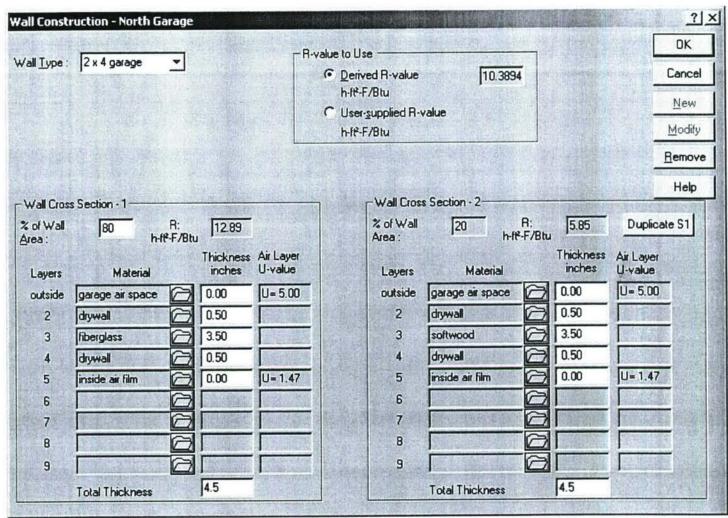
Walls Dialog Box



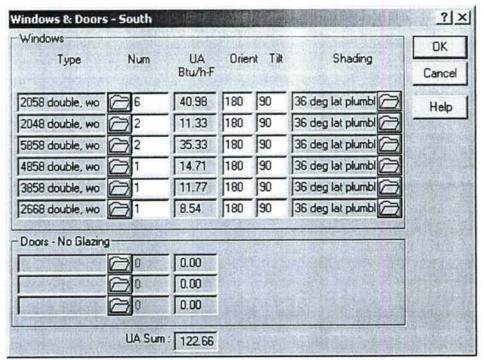
Wall Construction Dialog Box - Cypress Siding



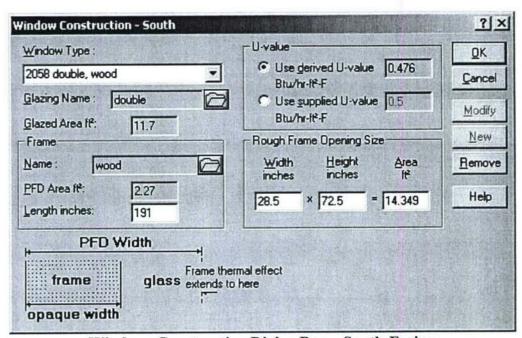
Wall Construction Dialog Box - Brick Veneer



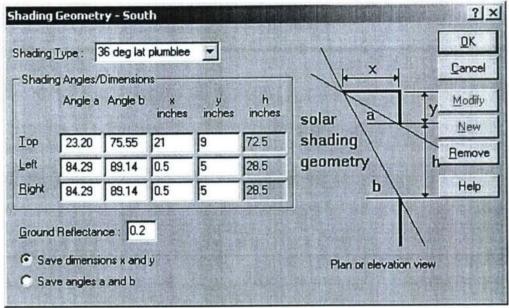
Wall Construction Dialog Box - Living Space to Garage



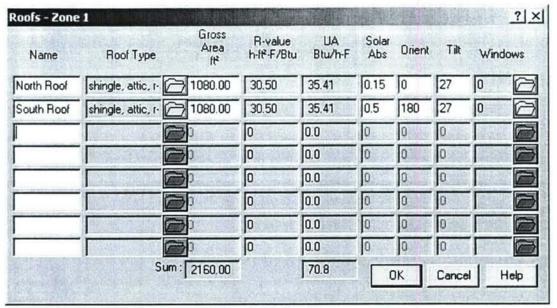
Windows & Doors Dialog Box - South-Facing



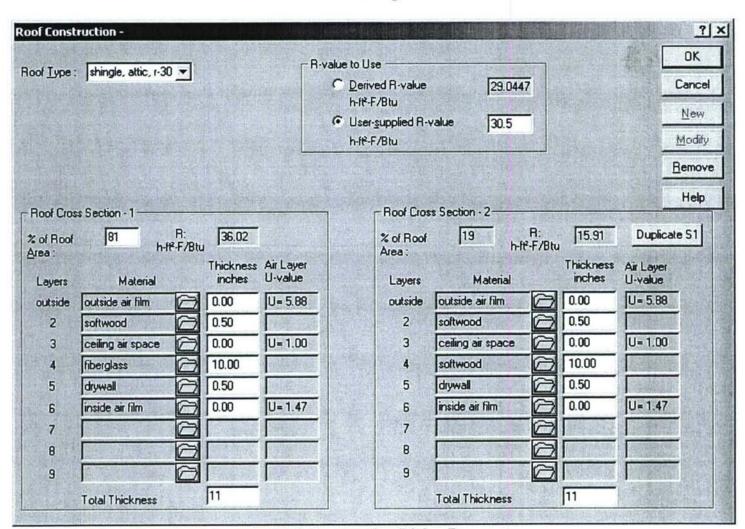
Windows Construction Dialog Box - South-Facing



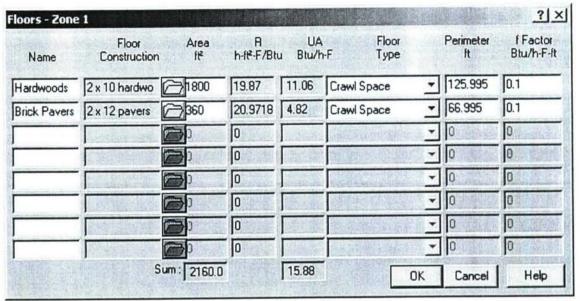
Shading Geometry Dialog Box - South-Facing



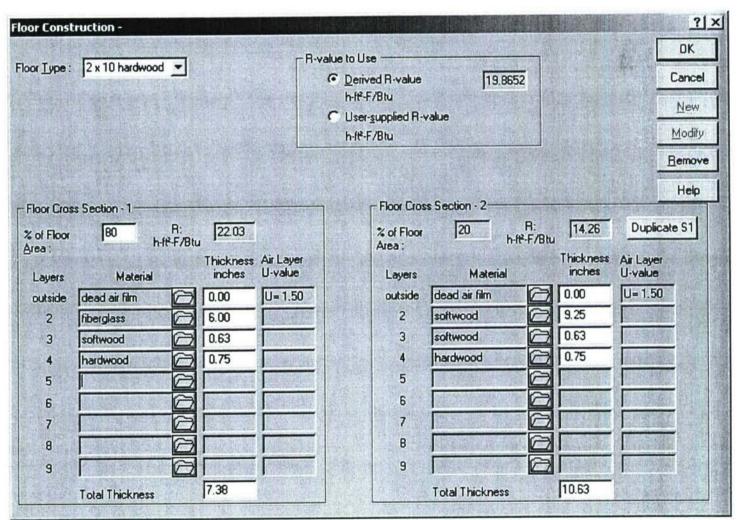
Roofs Dialog Box



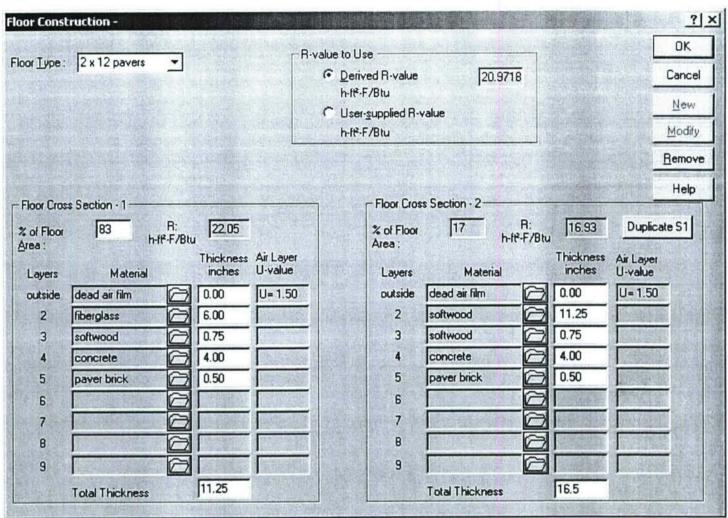
Roof Construction Dialog Box



Floors Dialog Box



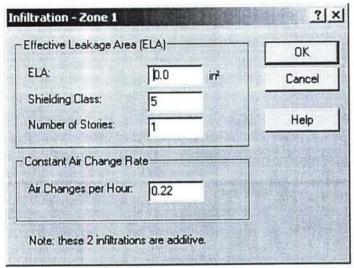
Floor Construction Dialog Box - Hardwood



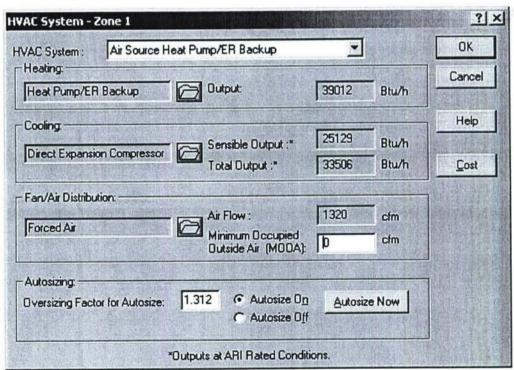
Floor Construction Dialog Box - Brick Pavers

terior Partitions (Ma	ss) - Zone 1		? ×
Name	Wall Type		Total Area
Furniture	furniture		300
Walls (interior)	2 x 4 partition		110
Brick Hearth	brick chimney		43.3
			0
			0
			0
			0
		0	0
		Sum	453.30
	QK C	ancel	Help

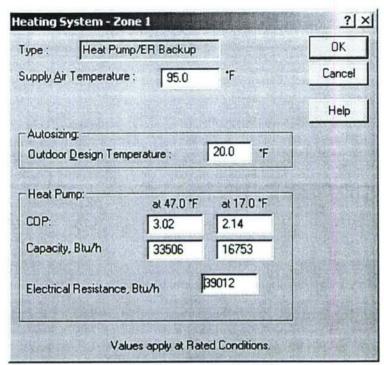
Interior Partitions Dialog Box



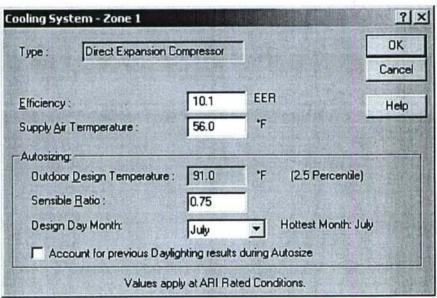
Infiltration Dialog Box



HVAC System Dialog Box



Heating System Dialog Box



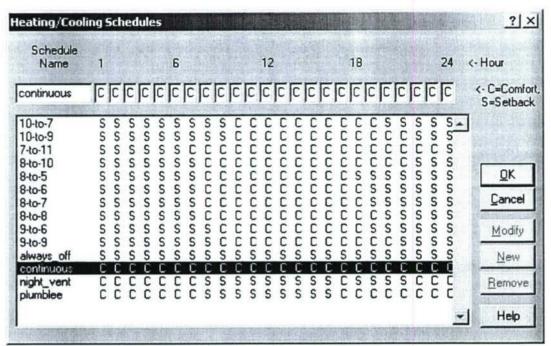
Cooling System Dialog Box

Air Distribution Type : Forced Air					
Supply:			Cancel		
Static Pressure :	0.2	inches of water	Help		
Fan Efficiency:	15	*			
Ouct Leakage to Dutdoors:	3	*			
Ouct Leakage to Indoors :	5	*			
Ouct Conduction to Outdoor:	5	2			
Return:					
Ouct Leakage from Outdoors:	3	Z Service			
Duct Conduction from Dutdoors:	5	*			
Exhaust Air Heat Recovery Efficiency :	İ	7 %			

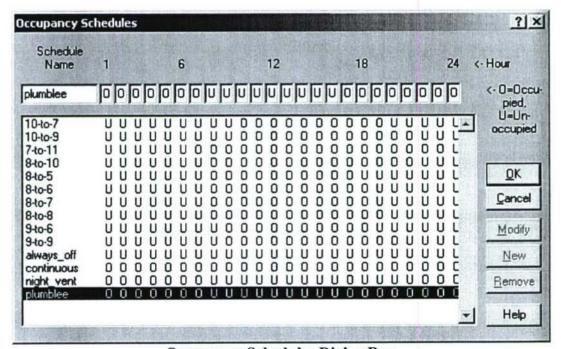
Air Distribution System Dialog Box

Schedules	Workday		Non-works	day	DK
leating & Cooling :	continuous	0	continuous	0	Cancel
Occupancy:	plumblee	0	continuous	0	Help
Setpoints	Comfort		Setback/Se	etuo	
leating:	68.0	'F	68.0	-F	
Cooling:	77.0	"F	77.0	-F	
Outside Air Oamper Interlock :	C Supply Far	, (© Occupancy	Schedule	
an Startup: Fi	xed Start Period:	0	hrs		
conomizer Cycle :	e No C	Yes			

HVAC Controls Dialog Box

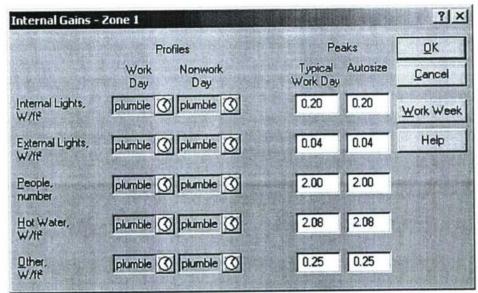


Heating/Cooling Schedules Dialog Box



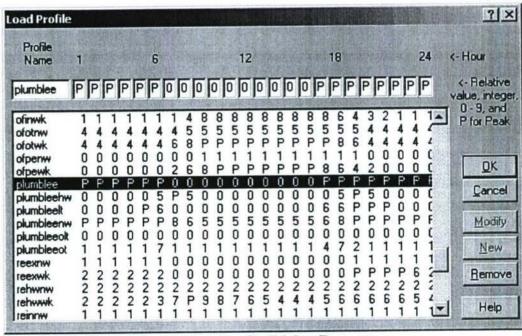
Occupancy Schedules Dialog Box

Note: The above Occupancy Schedule is only used for Temperature Set-backs. See Internal Gains for actual Occupancy Profiles.

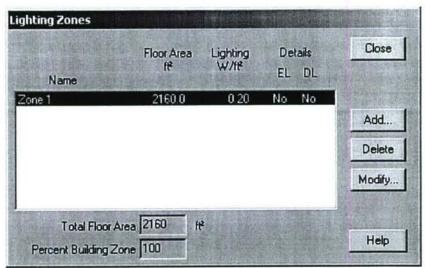


Internal Gains Dialog Box

Internal Lights External Lights People Hot Water Other Work Day Profile plumbleelt plumbleeolt plumblee plumbleehw plumbleeot Nonwork Day Profile plumbleelt plumbleeolt plumbleenw plumbleehw plumbleeot



Load Profile Dialog Box



Lighting Zones Dialog Box

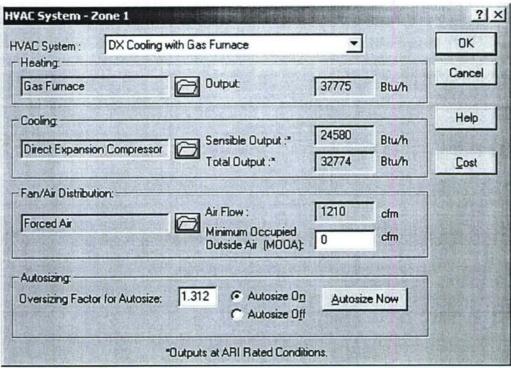
Note: Daylighting Dialog Boxes not used in this case study of the Plumblee Home. {Typical Daylighting Controls are only used in non-residential applications.}

Gas Furnace Case

Equivalent Heating Case using Gas Furnace in lieu of Heat Pump with Electric Heating.

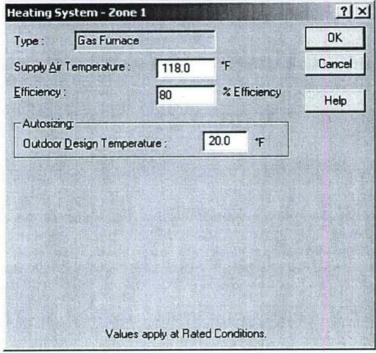
Note:

The Gas Furnace Case input is the base for all other varied cases.



{Only Dialog Boxes with Changed Input Presented}

HVAC System Dialog Box



Heating System Dialog Box

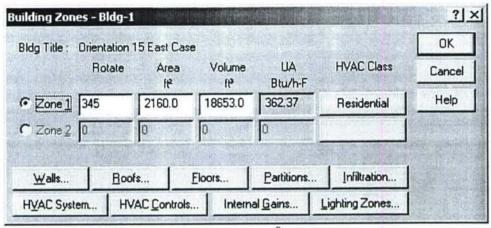
Type: T	Direct Expansion Co	mpressor		OK
				Cancel
Efficiency:	ACCOUNT OF THE	10.1	EER	Help
Supply <u>Air</u> Ter	mperature;	56.0	*F	
Autosizing:				
Dutdoor De	sign Temperature:	91.0	*F [2.5 F	'ercentile)
Sensible <u>R</u> a	atio:	0.75		
Design Day	Month:	July	→ Hottest	Month: July
T Accoun	t for previous Daylig	hting results	during Autosize	

Cooling System Dialog Box

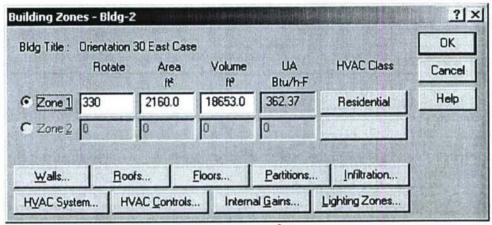
Air Distribution Type: Forced	Air	建加州 (基本)	OK
Supply:			Cancel
Static Pressure :	0.2	inches of water	Help
Fan Efficiency:	15	2	
Duct Leakage to Outdoors:	3	2	
Duct Leakage to Indoors :	5	2	
Duct Conduction to Outdoor:	5	_ x	
Return:			
Duct Leakage from Outdoors :	3	*	
Duct Conduction from Dutdoors:	5	*	
Exhaust Air Heat Recovery Efficiency:	j	7 %	

Air Distribution System Dialog Box

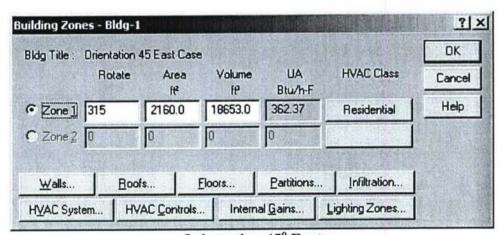
Orientation Cases



Orientation 15° East



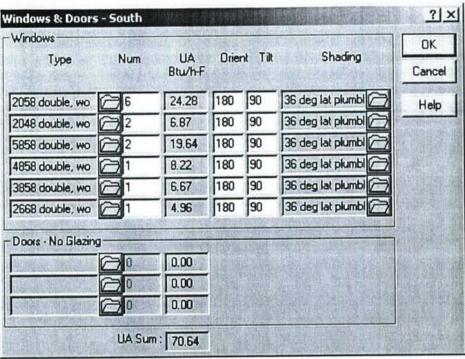
Orientation 30° East



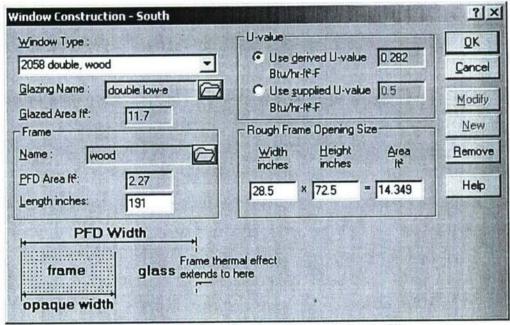
Orientation 45° East

Window Placement Cases

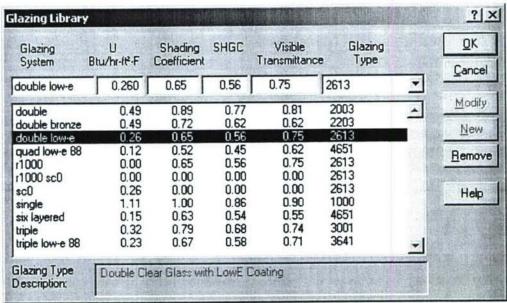
Case 1 - All south-facing windows changed to Low-E glass.



For South-Facing Windows - Low-E

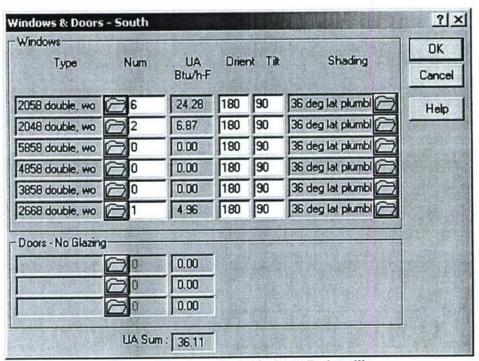


Change Glazing Name to "Double Low-E"



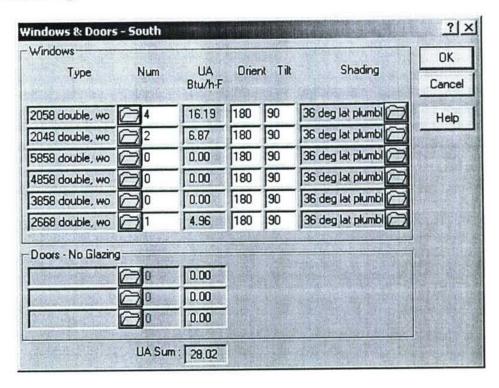
Glazing Library Dialog Box - Double, Low-E

Case 2 - Used 8 south-facing, Low-E windows.

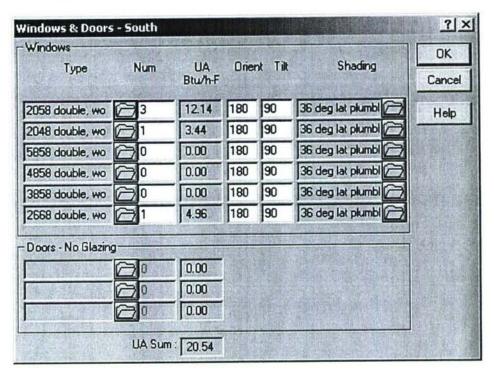


"Large Rectangular Windows Deleted"

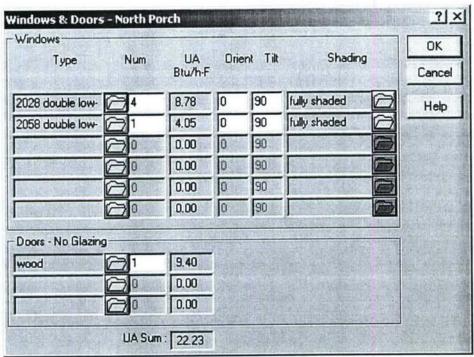
Case 3 - Used 6 south-facing, Low-E windows.



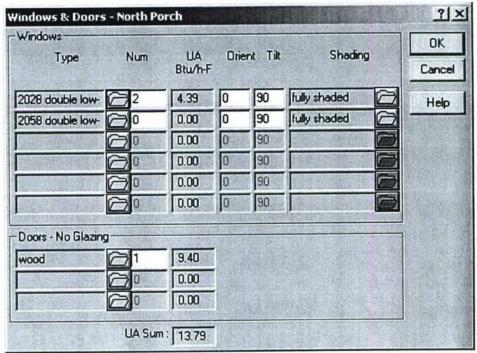
Case 4 - Used 4 south-facing, Low-E windows.



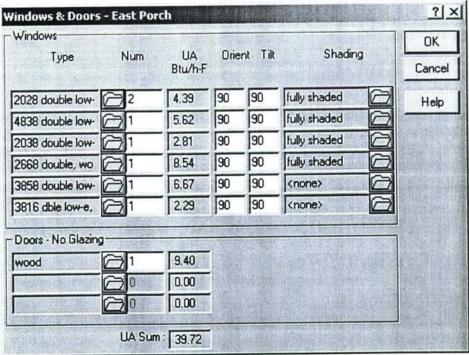
Case 5 - Used minimal glazing on North, East, and West exterior walls.



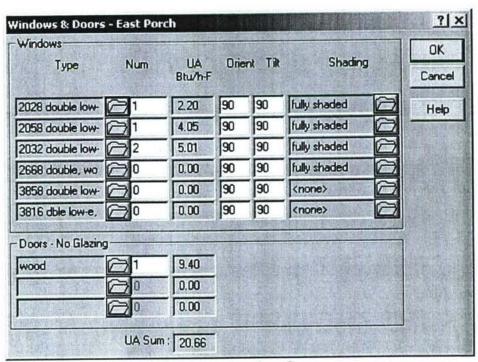
Energy-Efficient (Base) Case



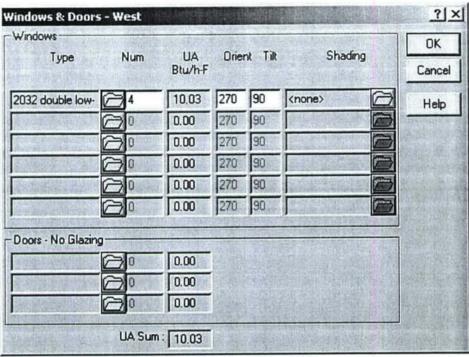
Minimal Glazing Case



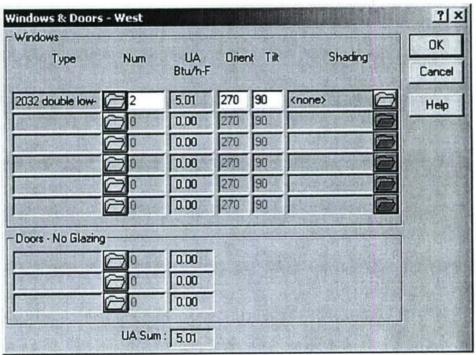
Energy-Efficient (Base) Case



Minimal Glazing Case



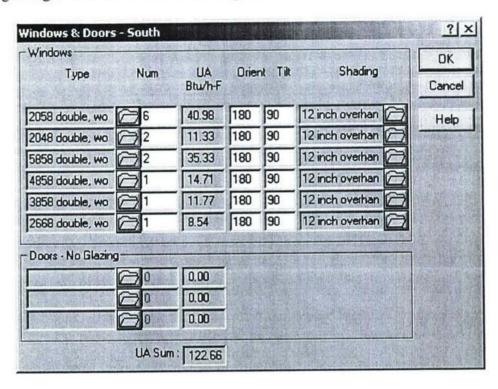
Energy-Efficient (Base) Case

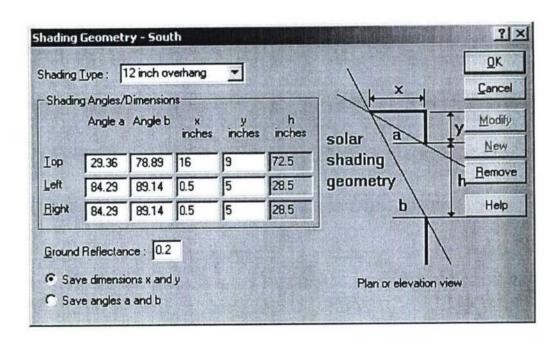


Minimal Glazing Case

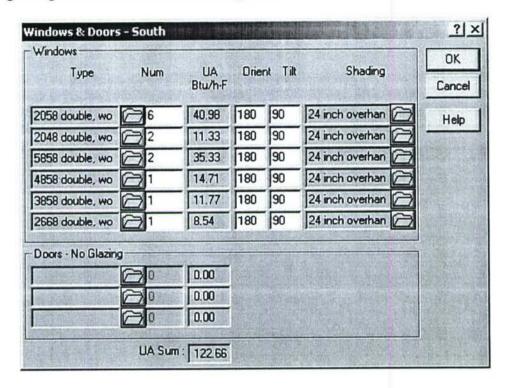
Shading Cases

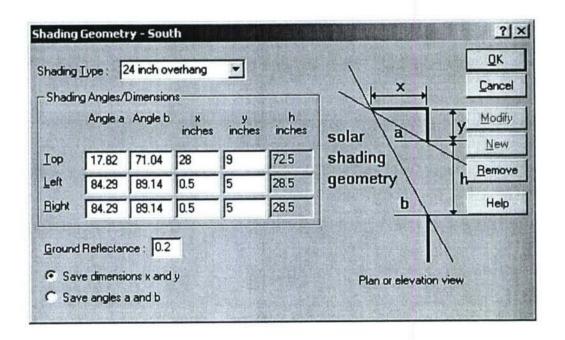
Case 1 - Overhang Design: 12 inch eave with 4 inch gutter.





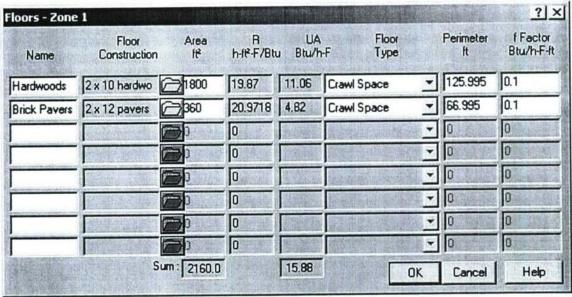
Case 2 - Overhang Design: 24 inch eave with 4 inch gutter.



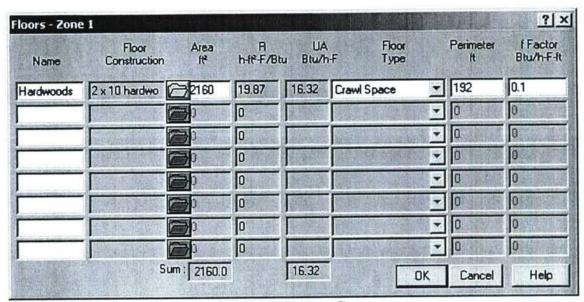


Heat Absorbing Material Case

Case 1 - Deleted thermal mass: No brick pavers and concrete floor sections.



Energy Efficient (Base) Case

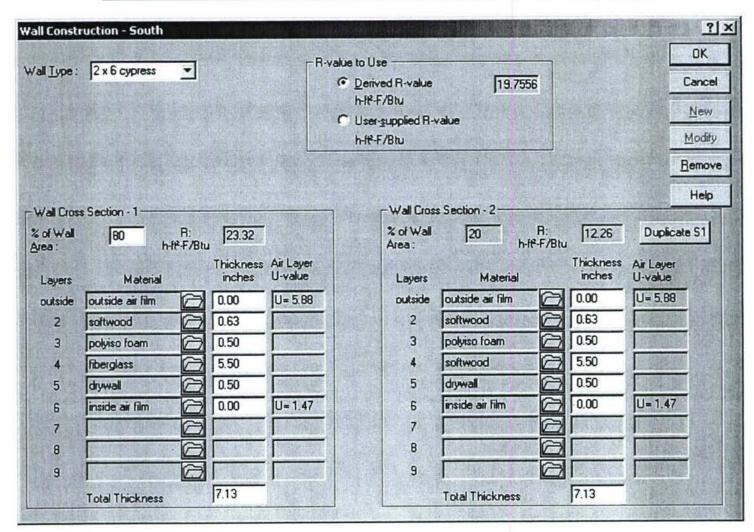


No Brick Pavers Case

Insulation Case

Case 1 – Replaced 2x4 exterior framing and R-13 batt-insulation with 2x6 and R-19.

Name	Wall Type	Gross Area ft²	R-value h-ft²-F/Btu	UA Btu/h-F	Solar Abs	Drient	Tilk	Windo Doo	
North Porch	2 x 6 cypress	275.58	19.76	10.75	0	0	90	5/1	0
East Porch	2 x 6 cypress	287.97	19.76	B.79	0	90	90	7/1	
South	2 x 6 cypress	480.05	19.76	11.35	0.5	180	90	13/0	
West	2 x 6 brick	287.97	18.38	13.84	0.1	270	90	4/0	
North Garag	2 x 6 garage	204.92	15.51	13.21	0	0	90	0/0	
	Sales in		0	0.0	0	0	0	2500	
			0	0.0	0	0	0	I STORE	
			0	0.0	0	0	0		
		Sum: 1536.49		57.9		OK	Cance	и н	elp



Air Infiltration Control Cases

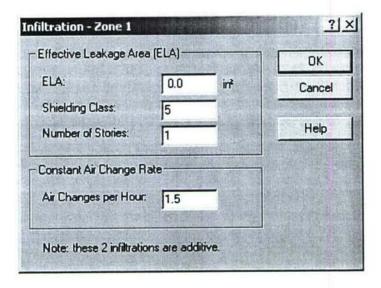
Case 1 - Used 0.5 Air-Changes per Hour (ACH).

ffective Leakage Area	(ELA)		OK
ELA:	0.0	int	Cancel
Shielding Class:	5		
Number of Stories:	1		Help
Constant Air Change Ra	te		
Air Changes per Hour:	0.5		

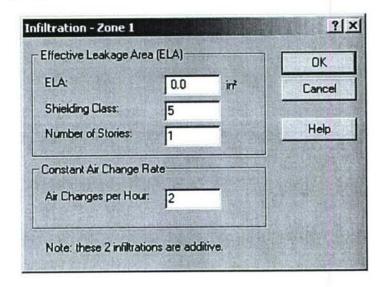
Case 2 – Used 1.0 Air-Change per Hour (ACH).

ffective Leakage Area	(ELA)		DK
ELA:	0.0	iri	Cancel
Shielding Class:	5		
Number of Stories:	Ī		Help
Constant Air Change Ra	nte -		
Air Changes per Hour:	1		
	120		

Case 3 – Used 1.5 Air-Changes per Hour (ACH).



Case 4 – Used 2.0 Air-Changes per Hour (ACH).



Indoor Air Temperature Control Cases

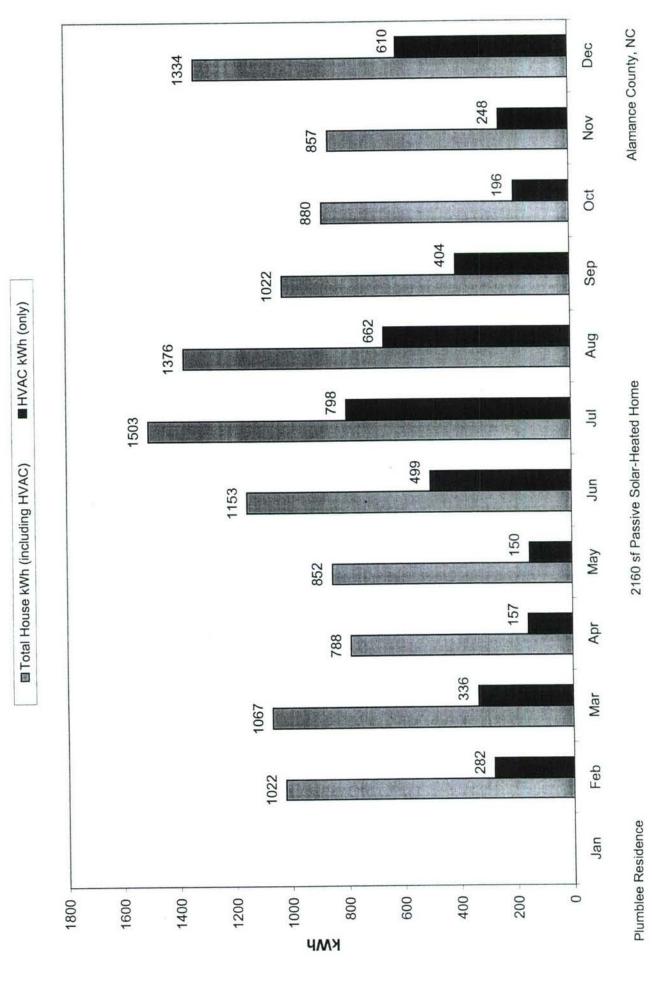
Case 1 – Winter Comfort Set-point: 72 °F Summer Comfort Set-point: 73 °F

	Workday		Non-works	dav	OK
leating & Cooling :	A VIOLENTIA DO		continuous	0	Cancel
	continuous			4 400 14	
ocupancy:	plumblee	0	continuous	0	Help
Setpoints					
the County of	Comfort		Setback/Se	etup	
leating:	72.0	'F	72.0	'F	
Cooling:	73.0	*F	73.0	*F	
Outside Air Oamper Interlock : Oan Startup: F	 Supply Faixed Start Period: 		Occupancy hrs	Schedule	
conomizer Cycle :		Yes			
CO IOI III CO CO CO		103			

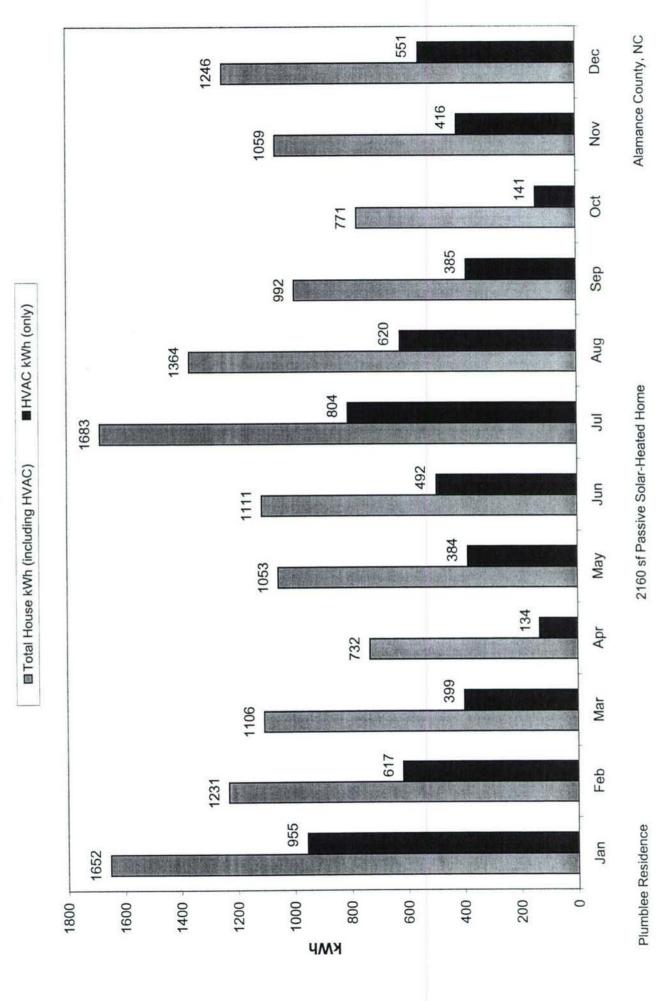
APPENDIX B

{Plumblee Home: Annual Monthly Energy Use}

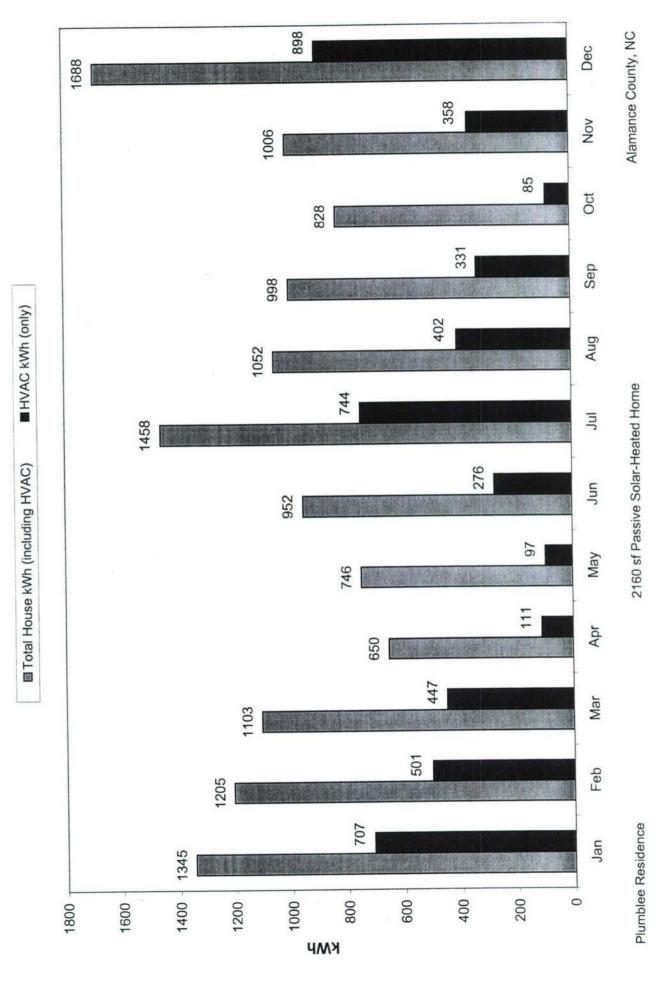
1990 Monthly Electric Use



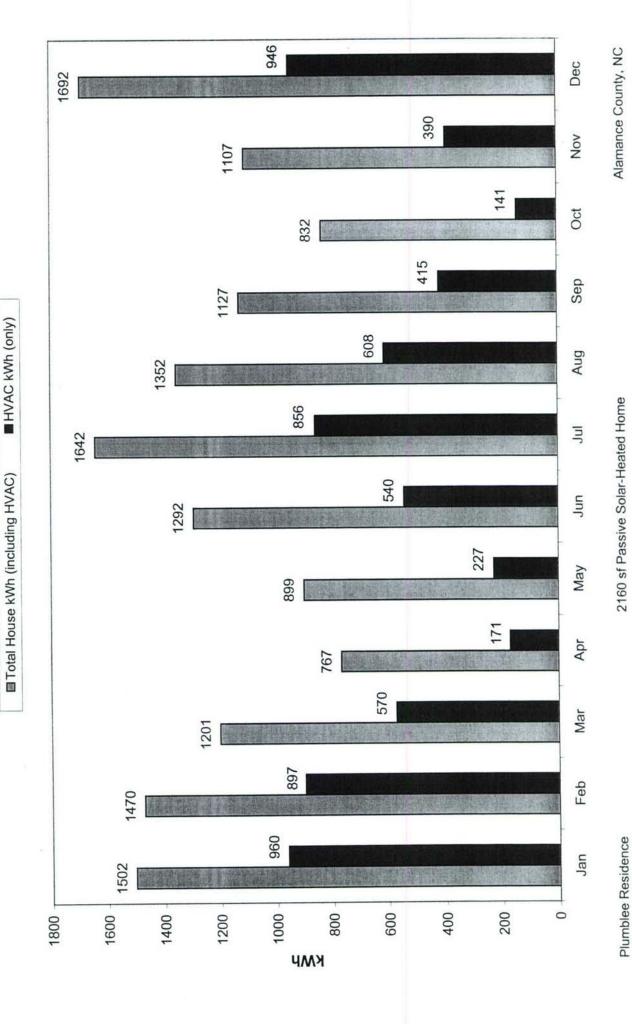
1991 Monthly Electric Use



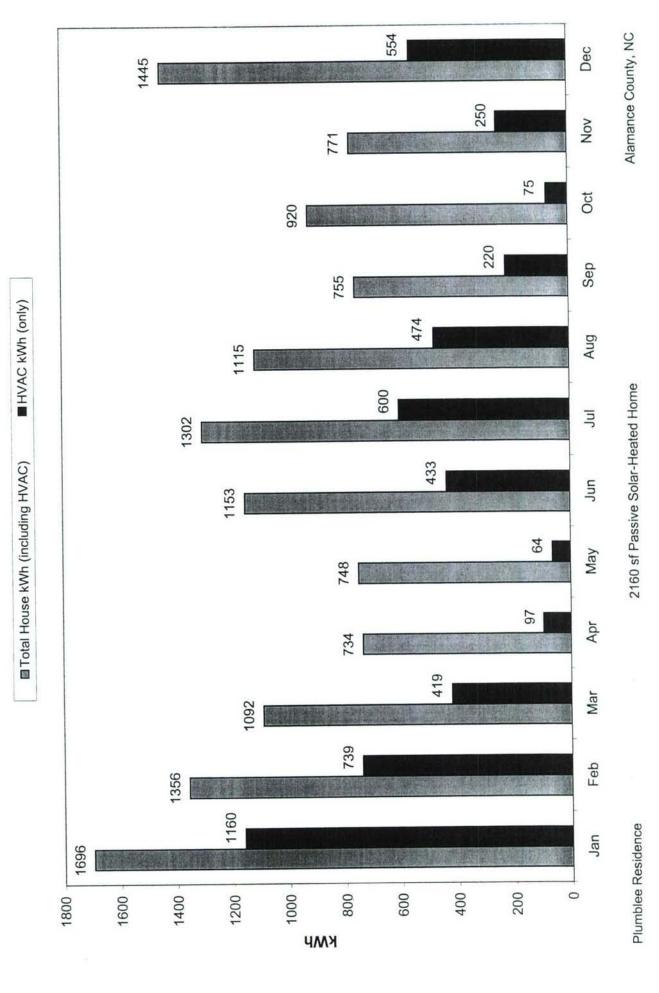
1992 Monthly Electric Use



1993 Monthly Electric Use

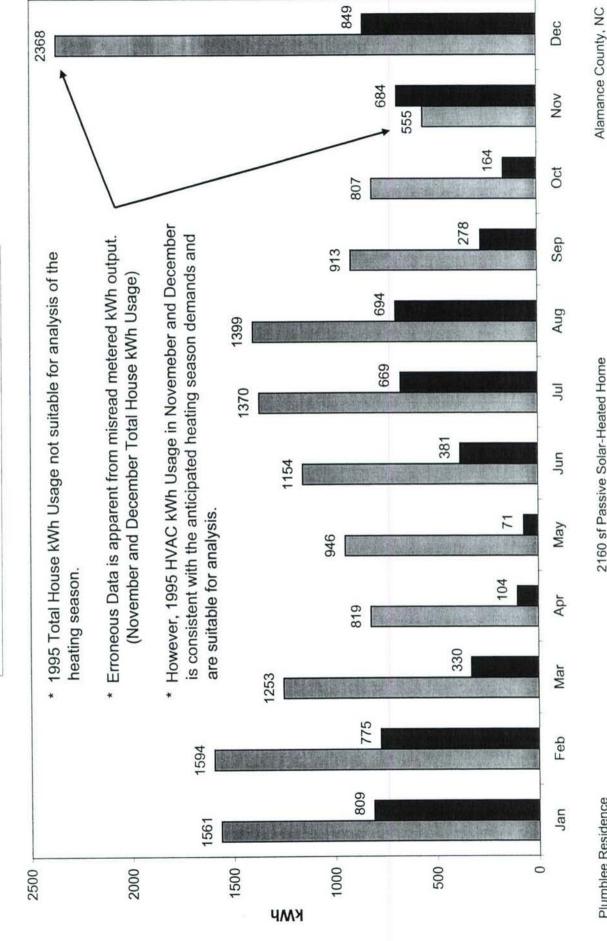


1994 Monthly Electric Use



■ HVAC kWh (only)

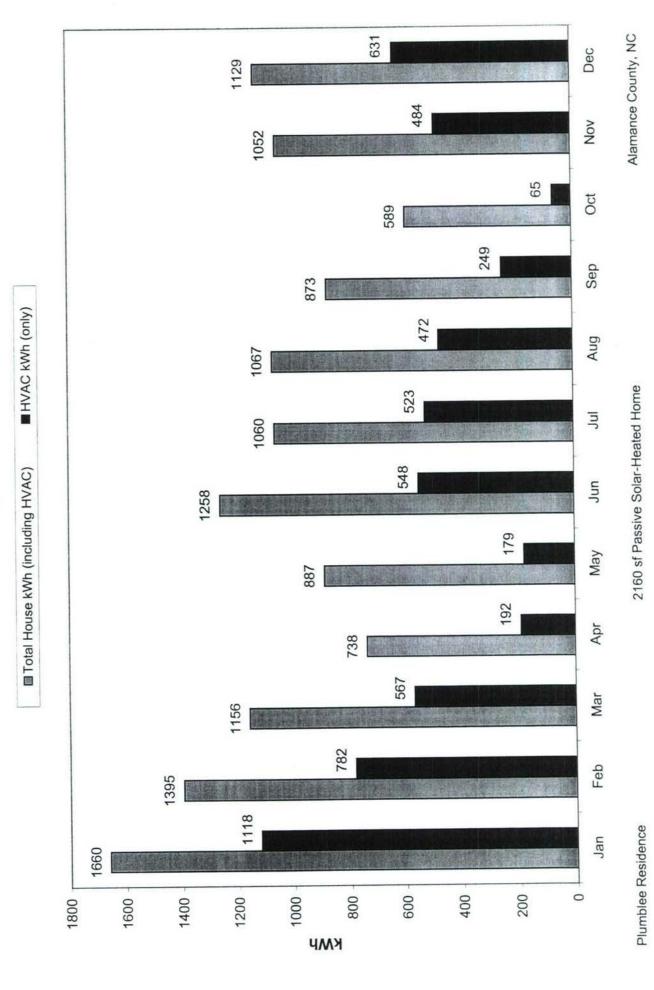
■ Total House kWh (including HVAC)



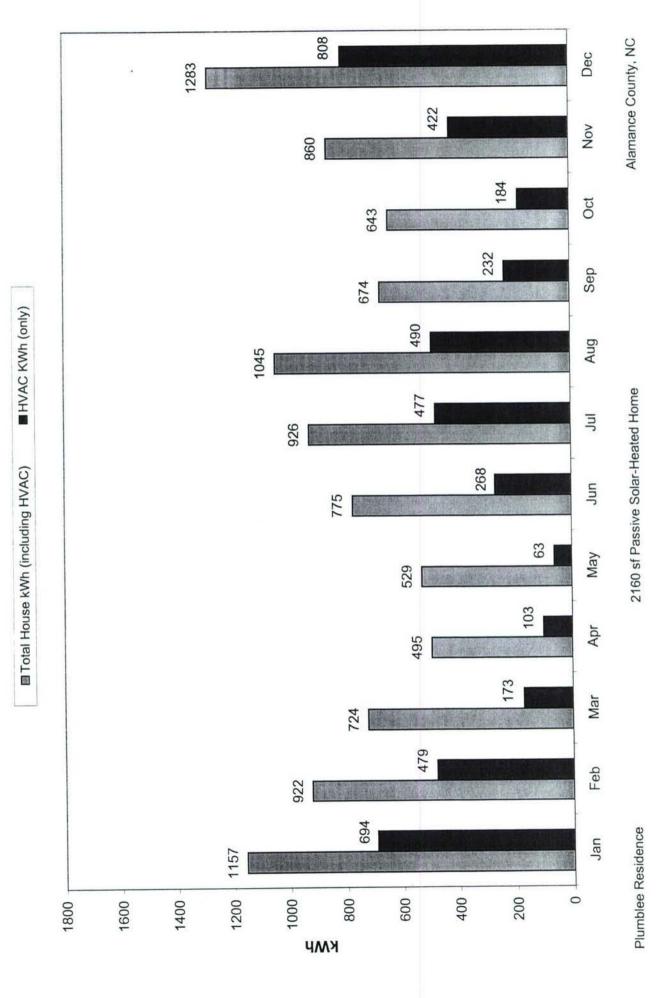
Plumblee Residence

2160 sf Passive Solar-Heated Home

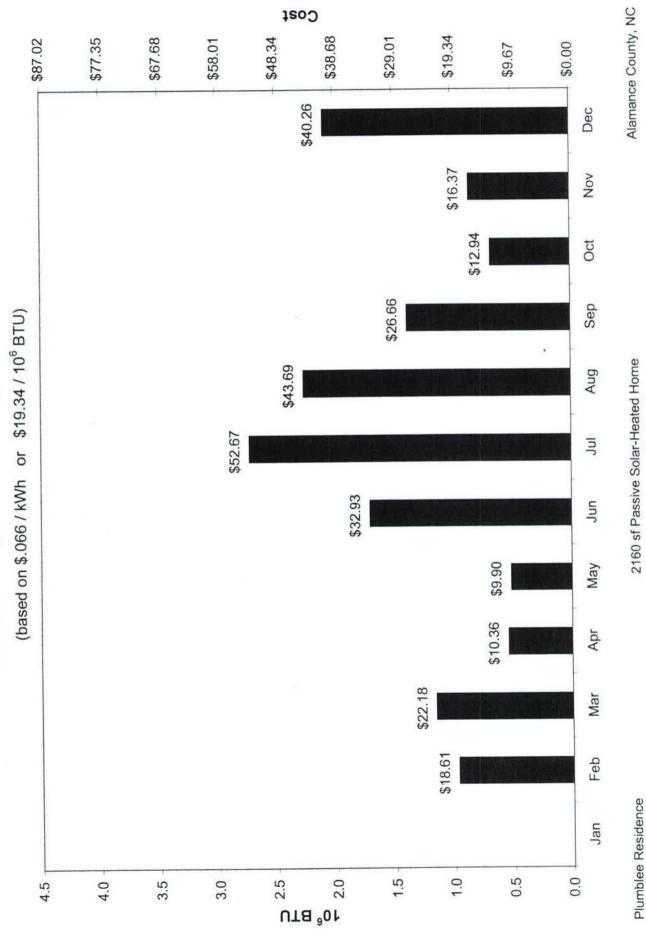
1996 Monthly Electric Use



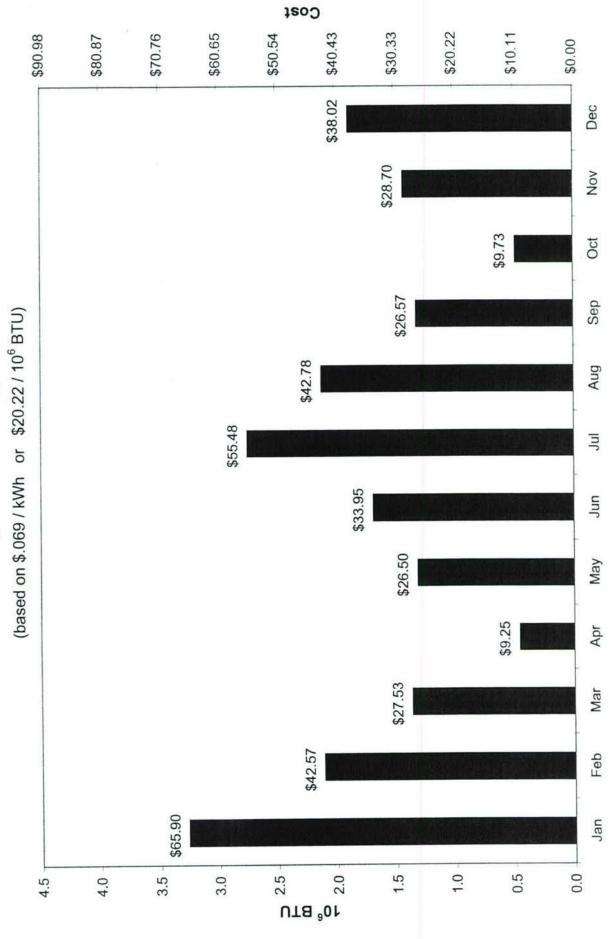
1997 Monthly Electric Use



1990 Monthly HVAC Energy Use / Cost



1991 Monthly HVAC Energy Use / Cost



Alamance County, NC

2160 sf Passive Solar-Heated Home

Plumblee Residence

Alamance County, NC \$20.22 \$30.33 \$10.11 \$60.65 \$40.43 \$90.98 \$70.76 \$50.54 \$80.87 \$0.00 \$61.96 Dec \$24.70 Nov \$5.87 Oct \$22.84 Sep (based on \$.069 / kWh or \$20.22 / 10⁶ BTU) \$27.74 Ang \$51.34 Jul \$19.04 Jun \$6.69 May \$7.66 Apr \$30.84 Mar \$34.57 Feb \$48.78 Jan 10⁶ BTU 2.5 1.0 0.5 0.0 1.5 3.0 4.0 3.5 4.5

2160 sf Passive Solar-Heated Home

Plumblee Residence

1992 Monthly HVAC Energy Use / Cost

teoD

Cost \$90.98 \$70.76 \$60.65 \$40.43 \$30.33 \$20.22 \$10.11 \$80.87 \$50.54 \$0.00 \$65.27 Dec \$26.91 Nov \$9.73 Oct \$28.64 Sep (based on \$.069 / kWh or \$20.22 / 10⁶ BTU) \$41.95 Ang \$59.06 Jul \$37.26 Jun \$15.66 May \$11.80 Apr \$39.33 Mar \$61.89 Feb \$66.24 Jan 10⁶ BTU 0.0 3.5 2.0 1.0 0.5 3.0 1.5 4.0 4.5

1993 Monthly HVAC Energy Use / Cost

Alamance County, NC

2160 sf Passive Solar-Heated Home

Plumblee Residence

Alamance County, NC \$10.11 \$30.33 \$20.22 \$40.43 \$60.65 \$90.98 \$80.87 \$70.76 \$50.54 \$0.00 \$38.23 Dec \$17.25 Nov \$5.18 Oct \$15.18 Sep (based on \$.069 / kWh or \$20.22 / 10⁶ BTU) 2160 sf Passive Solar-Heated Home \$32.71 Ang \$41.40 Jul \$29.88 Jun \$4.42 May \$6.69 Apr \$28.91 Mar \$50.99 Feb \$80.04 Jan UTB ⁸01 2.5 1.0 0.5 0.0 3.5 3.0 1.5 4.5 4.0

Plumblee Residence

1994 Monthly HVAC Energy Use / Cost

Cost

\$90.98 \$60.65 \$40.43 \$30.33 \$20.22 \$10.11 \$70.76 \$50.54 \$80.87 \$0.00 \$58.58 Dec \$47.20 Nov \$11.32 Oct 1995 Monthly HVAC Energy Use / Cost \$19.18 (based on \$.069 / kWh or \$20.22 / 106 BTU) Sep \$47.89 Aug \$46.16 Jul \$26.29 Jun \$4.90 May \$7.18 Apr \$22.77 Mar \$53.48 Feb \$55.82 Jan 0.5 0.0 UTB ⁸01 25 3.5 3.0 2.5 1.5 1.0 4.5 4.0

teoD

2160 sf Passive Solar-Heated Home

Plumblee Residence

Alamance County, NC

Alamance County, NC \$70.76 \$60.65 \$40.43 \$30.33 \$20.22 \$10.11 \$50.54 \$90.98 \$80.87 \$0.00 \$43.54 Dec \$33.40 Nov \$4.49 Oct \$17.18 Sep (based on \$.069 / kWh or \$20.22 / 106 BTU) 2160 sf Passive Solar-Heated Home \$32.57 Ang \$36.09 Jul \$37.81 Jun \$12.35 May \$13.25 Apr \$39.12 Mar \$53.96 Feb Plumblee Residence \$77.14 Jan 10⁶ BTU 25 0.0 4.0 0.5 3.5 1.5 1.0 3.0 4.5

1996 Monthly HVAC Energy Use / Cost

Cost

teoD \$102.84 \$22.85 \$11.43 \$68.56 \$34.28 \$91.42 \$79.99 \$57.13 \$45.71 \$0.00 \$63.02 Dec \$32.92 Nov \$14.35 Oct \$18.10 Sep (based on \$.078 / kWh or \$22.85 / 10⁶ BTU) \$38.22 Aug \$37.21 Jul \$20.90 Jun \$4.91 May \$8.03 Apr \$13.49 Mar \$37.36 Feb \$54.13 Jan 2.5 0.5 0.0 3.0 2.0 1.5 1.0 3.5 4.5 4.0 UTB ⁶01

1997 Monthly HVAC Energy Use / Cost

Alamance County, NC

2160 sf Passive Solar-Heated Home

Plumblee Residence

APPENDIX C

{Annual Climatology Data for Plumblee Home}

Annual Climatological Summary: 311239/99999, BURLINGTON FIRE STN #5, North Carolina

U.S. Department of Commerce National Oceanic & Atmospheric Administration

CLIMATOLOGICAL SUMMARY (1990) ANNUAL

Federal Building 151 Patton Avenue National Climatic Data Center Asheville, North Carolina 28801

Station: 341239/99999 BLIRI INGTON FIRE STN #5. North Carolina

Elev. 660 ft. above sea level

Lat. 36°04'N, Lon. 79°27'W

	DP10	/s	T	>=1.0	-	0	0	0	2	0	T	-	0	0	3	-	-	σ	,
	DP05 D	Number of Days	ŀ	>=.50 >=	9	4	2	-	8	-	c	7	4	0	9	2	3	30	00
	DP01 [Numb	ŀ	>=.10	8	9	5	2	10	3	1	n	9	-	6	3	7	88	200
(S			1	Max Date															
(inches	MXSD	Snow Sleet		Max Depth	0	0	0	0	0	0	1	٥	0	0	0	0	0	0	>
on (ir	TSNW	Sno		Total Fall	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	c	2
Precipitation		perved	200	Date	26	19	29	3	58	23	1	Ξ	23	14	11	10	4	100	5
Prec	EMXP	Greatest Observed	an incorpor	Day	1.10	0.62	0.70	0.61	1.15	0.50		1.10	0.95	0.12	2.80	1.40	1.30	00 0	7.80
	DPNP		Depart.	from	96.0	-0.33	Σ	-1.34	3.64	-3 28	04.0	-1.91	-0.69	-3.85	4.61	-0.62	0.53	1	Ξ
	TPCP			Total	4.63	3.28	2.57X	1.98	7.52	080	0.00	2.48	3.85	0.16	7.78	2.21	3 93	200	41.28X
	DT00	1	•	Min <=0°	0	0	0	0	0	c		0	0	0	0	0	C		0
	DT32	of Day	NUMBER OF Days	Min <=32°	17	14	8	4	0	C		0	0	0	-	7	14	100	69
	DX32	mhor	ingelli	Max <=32°	0	0	0	0	0	c		0	0	0	0	0	C	1	0
	DT90	Z	2	Max >=90°	0	0	0	3	0	45	7	21	16	9	0	0	6	1	58
		1		Low	13	25	80	80	12	4	n	0	31	25	27	30	26	1	Feb
	FMNP			Lowest	21	8	24	28	43	63	22	59	62	42	32	29	40	1	80
(° F)	<u> </u>	T		High	18	17	13	27	17	5	30	1	2	80	6	4	24	1	Sen
	FMXT	-		Highest	70	76	89	95	89	200	CA	66	98	66	89	80	7.5	7,	00
Temperature	CIDD	OFF	Cooling		0	c	21	4	82	2000	310	467	402	195	20	c			1568
Ter	UTTO	an I	Hosting	Degree	609	473	410	239	73	2	0	0	0	48	153	255	200	180	2051
	TIAGO	N L	Donat	from Normal	5.9	2 6	2.8	1 00	0 0	25.0	0.5	1.6	0.4					4.0	4.7
	MANTAN	MINIM		Mean	45.1	Var					75.2	79.9						45.7	000
	TIME	MMM		Mean					1		62.4	68.0	L			L	⅃	34.0	47.0
	1000	MMA		Mean	57 O		\perp	\perp	\perp	_	88.0	91.8	L					57.3	21.0
Date		Flem->		1990	MOHILI	C	7	2 3	1	0	9	7	· C	0	0 0	2		12	

(blank) Not reported.

- Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence. Used through December 1983 only
- A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).
 - B Adjusted Total. Monthly value totals based on proportional available data across the entire month.
- E An estimated monthly or annual total.

- X Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to 9 days that were missing.
- M Used to indicate data element missing.
- T Trace of precipitation, snowfall, or snowdepth. The precipitation data value
 - Elem- Element Types are included to provide cross-reference for users of the NCDC CDO System.
- Station Station is identified by: CoopID/WBAN, Station Name, State

the total accumulated amount appears in a subsequent monthly value. If TPCP = "M" accumulation began. The element TPCP accumulated amount value appears in a Example: Days 1-20 had 1.35 inches of S Precipitation amount is continuing to be accumulated. Total will be included in a during the month. Flag is set to "S" and there was no precipitation measured subsequent monthly or yearly value. would then be 00135S and the total precipitation, then a period of

> Dynamically generated Wed Jun 16 17:18:19 EDT 2004 via http://cdo.ncdc.noaa.gov/ancsum/ACS Data provided from the NCDC CDO System

Annual Climatological Summary: 311239799999, BORLINGTON TIRE STIV#5, North Caronna

U.S. Department of Commerce National Oceanic & Atmospheric Administration

ANNUAL CLIMATOLOGICAL SUMMARY

National Climatic Data Center Federal Building 151 Patton Avenue Asheville, North Carolina 28801

Page of 1

(1991)

311239/99999 BIIRI INGTON FIRE STN #5, North Carolina

Elev. 660 ft. above sea level

Lat. 36°04'N, Lon. 79°27'W

MNTM DPNT HTDD CLDD EMXT Mean Depart. Irom Degree D	Station: 311239/99999, BURLINGION FIRE SIN #5, North Ca	ъ.	9, 801	KLING		NE O IN	#2, rec		aioma					+			-		,				Γ
Depart Learning Lower Learning Learning Learning Learning Learning Learning Lower Learning Lea					Te	mper		E O	_								Pre	Sipitati	on (I	nches			
Part Part	MANYT MANIT IN	2	MTM	TNGO	HTDD	CLDD	EMXT		EMNP		_	DX32 E	3T32 E		H	DPNP	EMXP		TSNW	MXSD	DP0	-	DP10
Depart. Lowery Legacy. Lowery Legacy Lowery Legacy Legac	MIMIN	-	NIIA IIA			_				T	ž	umber o	f Days			Denart	Greatest Ob	perved	Snc	w, Sleet	Ŋ	Imber of D	Jays
39.7 0.0 0.0 0.0 1.35 1.50 1.35 1.50 0.0 0 10 39.7 0.0 0 7.5 0.0 0 0 0 1.93 -1.68 0.45 1.8 0.0 0 0 1.93 -1.68 0.45 1.8 0.0 0 0 1.93 -1.68 0.45 1.8 0.0 0 0 0 0 1.93 -1.68 0.45 1.8 0.0 0	Mean Mean		Mean	from Normal	Degree Days	_		High	97.95	-	°	0	2°	_		from	Day	Date	Total Fall		- 4		>=1.0
44.5 2.8 568 0 75 5 10 16 0 19 1.93 -1.68 0.45 18 0.0 0 19 1.93 -1.68 0.45 18 0.0 0 1.93 -1.68 0.04 10 0 0 5.61 1.54 2.00 30 0 0 0 5.61 1.54 2.00 30 0 0 0 5.61 1.54 2.00 30 0 0 0 0 2.58X M 0.69 30 0 0 0 0 2.58X M 0.69 30 0 0 0 0 2.58X M 0.69 30 0 0 0 2.52 1.16 1.00 0 0 2.52X 1.16 1.00 0 0 2.52X 1.16 0 0 0 2.52X 1.18 1.25 1.00 0 0 0 0 0 0	51.5 27.8	1 00	-			_	1	17	8	26	0	0	22	0	5.00	1.35	1.50	12	0.0	0	-		-
52.3 2.9 3.98 1.3 85 2.3 2.7 1.2 0 0 5.61 1.54 2.00 30 0.0 0 6.61 1.54 2.00 30 0.0 0 6.61 1.54 2.00 0 0 0 2.58X M 0.69 30 0.0 0 0 2.58X M 0.69 30 0 0 0 0 2.58X M 0.69 30 0		14				0	75	5	10	16	0	0	19	0	1.93	-1.68	0.45	18	0.0	0	+	5 0	0
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70.9 3.0 2.9 218 95 31 42 19 7 0 0 2.72 -1.16 1.00 20 0.0 0 2.72 -1.16 1.00 20 0.0 0 2.72 -1.16 1.00 20 0.0 0 2.29 -1.18 1.25 19 0.0 0 2.29 -1.88 1.25 19 0.0 0 2.29 -1.88 1.25 19 0.0 0 2.29 -1.88 0.15 0.0 0	L	160							29	2	0	0	-	0	2.58X	Σ	0.69	30	0.0	0	+		0
76.2 1.5 0.0 342 96 30 53 7 19 0 0 2.29 -1.88 1.25 19 0.0 0 2.29 -1.88 1.25 19 0.0 0 2.29 -1.88 0.15 0 0 0 0 0.229 19 24 0 0 0 6.32 1.93 3.40 3 0.0 0 0 4.38 0.16 1.85 15 0 0 0 4.38 0.16 1.85 15 0 0 0 0 4.38 0.16 0	L	15		-					42	19	7	0	0	0	2.72	-1.16	1.00	20	0.0	0	-		-
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Notes

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- Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence. Used through December 1083 and
- A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).
 - B Adjusted Total. Monthly value totals based on proportional available data across the entire month.
- E An estimated monthly or annual total.

- X Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to dour that was missing.
- M Used to indicate data element missing.
- T Trace of precipitation, snowfall, or snowdepth. The precipitation data value will = zero.
- Elem- Element Types are included to provide cross-reference for users of the > NCDC CDO System.
 - Station Station is identified by: CoopiD/WBAN, Station Name, State.

S Precipitation amount is continuing to be accumulated. Total will be included in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of precipitation, then a period of accumulation began. The element TPCP would then be 00135S and the total accumulated amount value appears in a subsequent monthly value. If TPCP = "M" there was no precipitation measured during the month. Flag is set to "S" and the total accumulated amount appears in a subsequent monthly value.

Dynamically generated Wed Jun 16 17:20:22 EDT 2004 via http://cdo.ncdc.noaa.gov/ancsum/ACS Data provided from the NCDC CDO System

U.S. Department of Commerce National Oceanic & Atmospheric Administration

CLIMATOLOGICAL SUMMARY (1992) ANNUAL

151 Patton Avenue Asheville, North Carolina 28801 National Climatic Data Center Federal Building

244226/00000 BUDUNGTON FIRE STN #5. North Carolina

Fley, 660 ft. above sea level

Lat. 36°04'N, Lon. 79°27'W

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MANTA MANTA MANTA HATDA CLD EMANTA CLD EMANTA CLD EMANTA CLD EMANTA MANTA MAN						Te	mper		e E	_								Pre	cipital		nche	es)			
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Min. Mean Min. Mean Min. Min. <th< td=""><td>€ </td><td>+</td><td>MIMIM</td><td>IAI A IIA</td><td></td><td></td><td>+</td><td></td><td></td><td></td><td></td><td>Z</td><td>nmper</td><td>of Days</td><td></td><td></td><td>Denart</td><td>Greatest Ob</td><td>perved</td><td>Snc</td><td>w, Slee</td><td>t</td><td>MuM</td><td>ber of D</td><td>ays</td></th<>	€	+	MIMIM	IAI A IIA			+					Z	nmper	of Days			Denart	Greatest Ob	perved	Snc	w, Slee	t	MuM	ber of D	ays
8 2.9.1 4.4.9 3.2 7.5 4.9 1.7 0 1.5 0 3.70 0.05 2.20 4 0.0 0 5 8 2.9.1 44.5 3.2 57.5 0 7.1 2.2 2.1 1.1 0 1.5 0 3.10 -0.51 1.63 2.6 0.0 0 5 2.3.2 44.9 3.2 57.5 0.0 8 2.5 2.1 1.1 0 0 1.3 0.05 1.17 1.28 7 0.0 0 6 0.0 0.1 0 0.1 0 0.0 0 0 0 0 0.0 0.0 0 0 0 0 0.0 0.0 0 0 0 0 0 0.0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	5 2	san	Mean	Mean	from Normal	Degree Days		Highest	High	ت	Low	Max >=90°	Max <=32°	s°2	_	1-1	from	Day	Date	Total Fall	Max Depth	Max Date			>=1.0
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46.8 60.8 -7.1 152 31 91 25 35 5 2 0 0 3.38 -0.50 0.70 30 0.0 0 10 0 3.38 -0.50 0.70 0 0 0 0 6.75 2.58 1.40 16 0 0 0 0 6.75 2.58 1.40 16 0 0 0 0 6.75 2.58 1.40 16 0 <	1	72.5	45.0									0	0	4	0	3.16	-0.16	2.05	22	0.0			9 9	- "	- 0
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67.7 79.8 1.5 0.0 464 100 14 62 13 24 0 0 2.49 -1.90 0.76 23 0.0 0 7 62.6 73.9 -3.5 0.0 2.49 -1.90 0.76 23 0.0 0 7 62.6 73.9 -3.5 0.0 0 3.57 -0.97 1.14 27 0.0 0 7 40.6 57.2 69.4 -1.6 43 30 2 0 0 0 1.97 -2.04 0.43 20 0 0 0 1.97 -2.04 0.43 20 0 0 0 1.97 -2.04 0.43 20 0 0 0 1.97 -2.04 0.43 0 0 0 0 1.97 -2.04 0.43 0 0 0 0 0 0 0 0 0 0 0 0 0		83.0	6.09							49			0	0	0	6.75	2.58	1.40	16	0.0			11	5	2
62.6 73.9 -3.5 -0.3 1.14 27 0.0 0 3.57 -0.97 1.14 27 0.0 0 7 57.2 69.4 -1.6 33 172 90 10 43 2 0 0 1.97 -2.04 0.43 20 0 0 7 -2.04 0.43 20 0 0 0 1.97 -2.04 0.43 20 0 0 0 1.42 2.25 2.50 0 0 0 1.42 2.25 2.50 0		91.8	67.7			1								0	0	2.49	-1.90	0.76	23	0.0			7	- 1	0
57.2 69.4 -1.6 33 172 90 10 43 30 2 0 0 1.97 -2.04 0.43 20 0 0 0 1.97 -2.04 0.43 20 0 0 0 1.97 -2.04 0.43 20 0 0 0 0 1.40 4 0 0 0 0 4.88 2.05 1.40 4 0 <td></td> <td>85.1</td> <td>62.6</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>0</td> <td>0</td> <td>0</td> <td>3.57</td> <td>-0.97</td> <td>1.14</td> <td>27</td> <td>0.0</td> <td></td> <td></td> <td></td> <td>2</td> <td>2</td>		85.1	62.6										0	0	0	3.57	-0.97	1.14	27	0.0				2	2
40.6 55.9 -3.9 27.3 0.0 83 16 28 20 0 4 0 5.42 2.25 2.50 5 0.0 0 0 6 6 9 6 9 6 1 0 4.88 2.25 1.40 4 0 0 9 9 38.7 49.7 -0.4 45.8 2 7 0 0 10 4.88 2.05 1.40 4 0 0 9 9 28.9 40.3 -1.4 759 0 6 30 13 1 0 44.33 -0.71 2.50 0 0 0 9 45.5 58.0 -1.3 3699 1228 100 Jul 10 10 44.33 -0.71 2.50 0 0 0 83		81.6	57.2										0	0	0	1.97	-2.04	0.43	20	0.0			,	0 0	0 0
38.7 49.7 -0.4 458 2 76 4 25 18 0 0 10 0 4.88 2.05 1.40 4 0 0 0 0 0 9 9 9 9 9 9 9 9 9 9 9 9 9		71.2	40.6				3 0	83				0	0	4	0	5.45	2.25	2.50	5	0.0			9	2	5
28.9 40.3 -1.4 759 0 66 30 19 7 0 0 23 0 3.01 -0.39 1.10 11 0.0 0 4 4.34 40.3 -0.71 2.50 Oct 0.0 0 83		9.09	38.7				8 2	16					0	10	0	4.88	2.05	1.40	4	0.0			6	3	2 2
45.5 58.0 -1.3 3699 1228 100 Jul 19 Dec 40 1 91 0 44.33 -0.71 2.50 Oct 0.0 0 83	1	51.7	28.9				6	99			7	0	0	23	0	3.01	-0.39	1.10	11	0.0	٥		4		7
		70.5	45.5										1	91		44.33	-0.71	2.50	Oct	0.0			83		16

Notes

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during the month. Flag is set to "S" and the total accumulated amount appears in a subsequent monthly value. If TPCP = "M" precipitation, then a period of accumulation began. The element TPCP accumulated amount value appears in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of S Precipitation amount is continuing to be accumulated. Total will be included in a there was no precipitation measured would then be 00135S and the total

> Dynamically generated Wed Jun 16 17:22:12 EDT 2004 via http://cdo.ncdc.noaa.gov/ancsum/ACS Data provided from the NCDC CDO System

Annual Climatological Summary: 311239/99999, BURLINGTON FIRE STIV #5, North Caromia

U.S. Department of Commerce National Oceanic & Atmospheric Administration

ANNUAL CLIMATOLOGICAL SUMMARY

National Climatic Data Center Federal Building 151 Patton Avenue Asheville, North Carolina 28801

Page of 1

(1993)

CONTRACTOR STATE S

Elev. 660 ft. above sea level

Lat. 36°04'N, Lon. 79°27'W

Station	Station: 311239/99999, BURLINGTON FIRE SIN #5, North Ca	6666/6	9, BUR	KLINGT	ON FIR	ESIN	ION 'C#	5	ILOIIIIa					-		1						١	Γ
Date					Te	Femperature		(° F)	_							Pre	Precipitation (inches	tion (inche	s)			
Date	_			1	. Com	00.00	EMVT		EMMD	٦	D TOO D	DX32 D	DT32 DT00	TPCP	P DPNP	EMXP		TSNW MXSD	MXSD	Ē	DP01 DF	DP05 DF	DP 10
Elem->	MMXT	MMN	MN	DPNI	нгор	CLUU	EMAI	1	CIMILA	1	2001	700		-	+			2	olo	t	Mumbar of Dave	of Day	
				1	- Inchine	Cooling					Nun	Number of Days	Days		Depart	Greatest Observed	Deserved	Sun	Show, Sieet	1	aniinni	0 0	,
1993	Mean	Mean	1	from from	Degree	Degree	Hinhest	High	lowest	Low N	Max M:>=90° <=	Max Mi <= 32° <=	Min Min <=32° <=0°	n 0° Total		Day	Date	Total Fall	Max	Max Date >	>=.10 >=	>=.50 >=	>=1.0
Month	Max.	2	Ē		2	1	_	'n	+-	28	c	o	19	0 3.89	39 0.39	1.07	5	0.0	0		7	4	1
	1 52.8	32.7	42.8	5.3	200			,	1	1	1	1	1	L	L		42	TOO	Į,	28	7	٣	C
	2 50.9	28.2	39.6	-1.0	705	0	89	22	16	19	0	0	22	3.59				0.0	5 9	07	+	, ,	0
	L	35.6	47.7	-1.8	529	0	75	31	8	15	0	0	11	0 8.50	50 4.62	3.10	4	X0.0	0	1	+	2	٧
				L	218	13	85	30	33	7	0	0	0	0 4.59	1.47	7 1.17	10	0.0	0	1	7	3	0
				l		187	ОВ	12	44	23	2	0	0	0 3.33	33 -1.00	0 0.78	31	0.0	0		7	3	0
	5 83.0	57.4	10.2					1		1	1	1	1	L	L		7	C	C	r	4	-	+
	6 89.3	63.8	76.6	2.0	0	355	99	11	54	9	-	0	9	0						t	+	+	T
			82.4	4.2	0	545	102	10	09	12	29	0	0	0 7.	7.36 2.76	6 2.28	3 20	0.0	0	1	C.	4	4
					٢	414	98	30	62	27	20	0	0	0 2.93	93 -1.34	4 0.74	14	0.0	0		80	4	0
	┙							L	AF	30	7	c	c	0 3.17	17 -0.41	1 2.00	5	0.0	0		3	2	-
	9 85.9	60.2	/3.1	7.7				1	2	3		1	-		44 242	0.44	0	00	C		33	0	0
-	10 71.9	9 44.0	58.0	-1.3	235	25	85	21	33	30	0	0	٥	-	1				9	Ť	1	,	1
-		L	49.9	-0.5	450	9	84	16	24	6	0	0	13	0 3.	3.73 0.66	6 2.02	2 28	0.0	0	1	4	7	٧
					L	٥	68	4	15	31	0	-	24	0 2.	2.29 -1.17	7 0.80	21	1.0	0		8	-	0
	12 50.5	26.0			1			L		1	75	+	00	0 48 12	1 16	3 10	Mar	1 0X	0	Feb	20	30	14
Annual	al 72.2	47.0	59.7	1.0	3623	1801	102	Jul	8	Mar	(2)	=	80	_	╛			┚			1	1	1

Notes

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Dynamically generated Wed Jun 16 17:23:43 EDT 2004 via http://cdo.ncdc.noaa.gov/ancsum/ACS Data provided from the NCDC CDO System

Additional documentation can be found at http://www5.ncdc.noaa.gov/cdo/3220doc.txt

http://cdo.ncdc.noaa.gov/ancsum/ACS

Annual Climatological Summary: 311239/99999, BURLINGTON FIRE STN #5, North Carolina

U.S. Department of Commerce National Oceanic & Atmospheric Administration

ANNUAL CLIMATOLOGICAL SUMMARY

National Climatic Data Center Federal Building 151 Patton Avenue Asheville, North Carolina 28801

(1994)

341239/99999 BURLINGTON FIRE STN #5, North Carolina

Elev. 660 ft. above sea level

Lat. 36°04'N, Lon. 79°27'W

	DP10	9710	dys	>=1.0	2	-	100	7		0	0		7	-	0	0	C		0	10	
	DP05	horof	Number of Days	>=.50	4	2	¥		7	-	C		٩	4	0	0	ľ		0	24	
	DP01	1	MUM	>=.10	7	3	7		9	2	5	ì	10	7	3	4	ſ	°	4	61	
es)		,	et	Max Date	0	0			0	0	0		0	0	0	0		5	0	0	
(inches	MXSD	ā	Snow, Sleet	Max Depth																	
	TSNW	1	מ	Total Fall	X0.0	XUU		0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	X0.0	
Precipitation		1	served	Date	28	24	1	7	16	4	30	200	29	30	2	14	- 00	67	23	Mar	
Prec	EMXP		Greatest Observed	Day	1.12	1 07	0.	1.86	1.55	0.86	24.0	0.47	1.20	1.60	0.30	0.37	5.0	0.78	0.21	1.86	
	DPNP		Depart.	from	Σ	1 24	177	2.04	-0.70	Σ	1	Σ	1.84	0.40	-2.78	2000	-2.03	-1.52	-2.71	Σ	
	TPCP	5		Total	4.77X	2 30	4.00	5.92	2.42	1.10X	200	1.3/X	6.44	4.67	0.80	1 17		1.55	0.75	33 35X	
	DTO		/s	Min <=0°	3			0	0	0		0	0 0	0 0	0			0 9	15 0	76 2	
	2 DT32	7 0 1 36	Number of Days	Min <=32°	3 26	L	2	0	0	0		0	0	0	0	0 0		0	1	2	
	O DX32	200	Numbe	Max 0° <=32°			5	0	1	6		16	25	17	6	, (5	0	0	20	00
	DTO	2		Low Max Date >=90°	-	1	=	-	8	8		5	29	25	21	1 8	97	24	13	50	Jan
	MAID	L		Lc west Dz	-	1	18	26	34	An	7	20	62	51	50	3 8	32	29	22	┸	7-
Œ	1	EN		High Date Lov		2 2	71	6	27	25	24	20	21	=	4	2 0	3	15	80	+	Jun
lre (°	15.	EMAI	_	Highest	+-	1	9/	81	92	2	5	101	98	96	000	36	82	78	78	┸	101
Temperature	1	-	in a	Degree Hin	1	7	0	0	62	000	00	351	473	313	405	120	11	2	-		1421
Temr	10	HIDD CLUD	Н	Degree Deg	-	240	662	428	136	400	102	0	0	C	2 1	13	234	345	587	1	3457
	h	DPNT	-	from De	-	-3.3	9.0	1.5	3.7		Q.Z-	1.9	1 8	2.4	7.00	-2.0	-1.7	3.0	7 7	1	0.5
	н	MNTM	-		_	34.2	41.2	51.0	623	0.70	2.49	76.5	80.0	1,0	6.4.0	68.4	57.6	53.4	70.0	40.0	402
	- 1-	MMNT		-		47.77	28.9	37.7	46.0	40.5	49.6	63.6	67.7		01.0	55.8	43.5	30 0	20.00	33.1	16.0
	- 1	MMXT	-	-		46.0	53.4	64.3	77.6	0.77	78.8	89.3	00 0	37.70	0.00	81.0	71.7	8 8 8	0.00	200.0	700
ate	_	Elem->			Month	-	2	8	1	4	2	9	7	-	0	6	10	44		71	Annual

Notes

(blank) Not reported

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Dynamically generated Wed Jun 16 17:24:00 EDT 2004 via http://cdo.ncdc.noaa.gov/ancsum/ACS Data provided from the NCDC CDO System

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CLIMATOLOGICAL SUMMARY (1995) ANNUAL

Federal Building 151 Patton Avenue Asheville, North Carolina 28801

National Climatic Data Center

Page 1 of 1

Station: 311239/99999 RUBI INGTON FIRE STN #5. North Carolina

Elev. 660 ft. above sea level

Lat. 36°04'N, Lon. 79°27'W

Station: 311239/99999, BURLING ION FIRE 31N #3, NOTH CAROLINA	3112	39/9993	3, DOL	KLING	LI NO	1103	10, 10	5				1		-										
Date					Te	Temperature		(° F)	_								Pre	Precipitation	tion ((inches	es)			
Elem->	MMXT	MMNT	MLNM	DPNT	HTDD	CLDD	EMXT		EMNP		DT90 [DX32 [DT32 D	DT00 TP	TPCP D	DPNP	EMXP		TSNW	MXSD		DP01	DP05	DP10
				Donor	Hosting	Cooling					Z	Number of Days	of Days		0	Depart.	Greatest Observed	served	Sno	Snow, Sleet	at	Num	Number of Days	ays
1995 Mooth	Mean	Mean	Mean	from	Degree	Degree	Highest	High	Lowest	Low	Max N	Max N	Min N <=32° <	Min <=0° Tc	Total	from	Day	Date	Total Fall	Max Depth	Max Date	>=.10	>=.50	>=1.0
MOIN	1 50.7				749		1	15	14	9		-	20	0	4.94	1.44	2.00	15	0.0T	TO	31	7	2	2
	2 50.9		1	-1.3	712	0	74	27	11	7	0	-	20	0	3.21	-0.42	1.50	17	0.0	0		5	2	2
	3 67.4	39.1	53.3	3.8	356	2	83	23	22	5	0	0	9	0	3.57	-0.31	1.20	6	0.0	0		8	1	-
	4 74.7	43.9	59.3	0.7	204	40	91	21	30	3	2	0	2	0	0.70	-2.42	0.50	13	0.0	0		2	-	0
	5 79.4	55.5	67.5	0.7	55	139	92	19	38	4	1	0	0	0	3.52	-0.81	06.0	3	0.0	0		10	2	0
	6 85.6	5 61.8	73.7	-0.9	-	271	96	10	24	24	9	0	0	0 1:	12.00	7.74	4.40	29	0.0	0		16	5	5
	7 92.9	9 68.5	80.7	2.5	0	492	66	25	61	9	23	0	0	0	4.97	0.37	1.17	31	0.0	0		9	4	-
	8 90.5	5 68.8	79.7	2.7	0	461	100	17	64	29	20	0	0	0	5.06	0.79	4.67	28	0.0	0		2	1	-
	9 81.0	57.5	69.3	-1.1	32	165	94	2	43	29	2	0	0	0	1.67	-1.91	0.74	23	0.0	0		4	-	0
10	0 75.0	0 48.4	61.7	2.4	143	47	87	4	37	31	0	0	0	0	6.84	3.58	2.50	21	0.0	0		5	3	3
11	1 57.8	33.6	45.7	4.7	573	0	73	29	25	16	0	0	18	0	4.03	96.0	06:0	8	0.0	0		10	3	0
-	12 48.8	8 25.4	37.1	-4.2	860	0	73	16	8	25	0	0	27	0	0.94	-2.52	0.80	6	0.0	0		-	-	0
Annual	al 71.2	2 46.7	59.0	0.3	3685	1618	100	Aug	8	Dec	54	2	93	0 2	51.45	6.49	4.67	Aug	0.0	0	Jan	79	26	15

Notes

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> Dynamically generated Wed Jun 16 17:24:34 EDT 2004 via http://cdo.ncdc.noaa.gov/ancsum/ACS Data provided from the NCDC CDO System

Annual Climatological Summary: 311239/99999, BURLINGTON FIRE STN #5, North Carolina

U.S. Department of Commerce National Oceanic & Atmospheric Administration

CLIMATOLOGICAL SUMMARY ANNUAL

Federal Building 151 Patton Avenue National Climatic Data Center Asheville, North Carolina 28801

p: 341239/99999 BURI INGTON FIRE STN #5. North Carolina

Elev. 660 ft. above sea level

Lat. 36°04'N, Lon. 79°27'W

	DP 10		Days	>=1.0	-	0	0	1	0	2	0		0	5 2	2	1	3	3 0	3 0	12	
	DP05		Number of Days	>=.50	3	0	6				ľ	1	,		_					100	
	DP01		NUN	>=.10	4	2	ď		9	8	4	1	9	9	11	1	2	9	8		13
(Se		Ī		Max Date	7															L	o Jan
uche	MXSD	1	Snow, Sleet	Max Depth	9	°	1		0	0	١		0	0	6		٥	0	١		
ion (ii	TSNW	1	Sno	Total Fall	12.0X	X0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	0	3	0.0	0.0	0	1	12.UX
Precipitation (inches			served	Date	27		Ī	1	2	-	Ç	2	6	28	u		2	6	٦	-	Sep
Prec	FMXP		Greatest Observed	Day	1.04	Σ	1	Σ	0.50	1.20	000	0.00	16.0	3.00	E 45	00	1.51	0.85	0 0	0.0	Σ
	DPNP		Depart.	from	Σ	N		1.44	Σ	1.46	000	-2.83	-1.66	2.92	0 45	0.13	0.99	-0.01	0.20	0.30	Σ
	TPCP	5		Total	2.63X	1 86 X	1	5.35	2.18X	5 79		1.43	2.94	7.19	44.70	27.11	4.25	3.06	200	5.04	52.22X
	DTO	3	2	Min <=0°	0	c	1	0	0	C	1	0	0	0	-	2	0	0			0
	DT32 DT00	2010	of Day	Min <=32°	26	40	61	15	9	0		0	0	0	1	2	0	20		4	105
	DX32	7000	Number of Days	Max <=32°	3	4	1	0	0	٥		0	0	0	ľ	2	0	°		2	8
	DTO	000	z	Max >=90°	0	9		0	0	0	9	15	21	7		5	0	0		٦	55
				Low	23	1		10	6	-		2	5	ľ	1	15	13	12		77	Feb
	CAAAID	EMINE		lowest	17	1	4	13	28	27	5	43	53	58	3	38	35	21	1	12	4
(e F)				High	200	2 6	87	15	29	22	77	25	20	α	٦	10	17	٦		13	Jun
ture	TANA	EMXI		Hinhest	89	8	6)	77	85	00	20	100	98	0	0.1	91	82	84	01	78	100
Temperature	20.00	CLUU	Cooling	Degree	10	1	0	0	14	007	701	340	407	240	210	128	0	c	2	0	1370
Ter		HTDD	-	Degree	720	100	741	662	270		64	4	C		2	16	225	Con	200	647	4078
	t	DPNT	Н	_	Morning	-0.0	-1.4	-6.0	-23	2	1.2	1.4	0		-Z.U	-1.9	-17		p.4	2.5	1 4
		MNTM		2	Ξ		39.2	43.5			68.0	76.0			75.0	68.5			45.5	43.8	673
		MMN		Mean	2	72.4	26.7	319			54.4	62.4		1	63.7	56.3	L		30.8	28.6	44.0
		MMX		Mean	Max.	48.0	51.7	55 1	┸		81.5	89.5			86.2	80.7			60.1	59.0	70.0
Date	Calc	Elem->		1996	Month	-	2	3		1	5	9	1		8	6	45	2	11	12	

(blank) Not reported

- + Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence. Used through December
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- T Trace of precipitation, snowfall, or snowdepth. The precipitation data value
 - Elem- Element Types are included to provide cross-reference for users of the NCDC CDO System.
- Station Station is identified by: CoopID/WBAN, Station Name, State

during the month. Flag is set to "S" and the total accumulated amount appears in a subsequent monthly value. If TPCP = "M" accumulation began. The element TPCP accumulated amount value appears in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of Precipitation amount is continuing to be accumulated. Total will be included in a there was no precipitation measured would then be 00135S and the total precipitation, then a period of subsequent monthly value

> Dynamically generated Wed Jun 16 17:25:13 EDT 2004 via http://cdo.ncdc.noaa.gov/ancsum/ACS Data provided from the NCDC CDO System

Annual Climatological Summary: 31123979999, BURLINGTON FIRE STIV #5, Forth Caronna

U.S. Department of Commerce National Oceanic & Atmospheric Administration

CLIMATOLOGICAL SUMMARY ANNUAL

151 Patton Avenue Asheville, North Carolina 28801 National Climatic Data Center

Page of

(1997)

244239/99999 RIIRI INGTON FIRE STN #5, North Carolina

Elev. 660 ft. above sea level

Lat. 36°04'N, Lon. 79°27'W

۲ د	_	0		0	0	0	0	T	٧]	0	-	2	T	T	7	0	-	0	ग	6
N 17 61		DP 10	Days	>=1.0	4	2	2		Ç	0	2	6	1	_	3	2	3	0		27
2		DP05	Number of Days	>=.50													10	0		
_at. 3b 04 N, Lon.		DP01	Nun	>=.10	5	7	10	1		4	7	00		7	4	4	9	1		70
0 04	(S)			Max Date			T	T	1				T					000	OS .	Dec
.at. 3	(inches	MXSD	Snow, Sleet	Max Depth	0	0	C	1	٥	0	0	C	1	0	0	0	0	c	?	2
-		TSNW M	Snow	-	X0.0	0.0	0 0	3	0.0	0.0	0.0	0	2	0.0	0.0	0.0	0.0	20	V0.0	X0.0
	ation	TSI		Tota	0 6	15	14	+	29	27	3	22	2	21	10	27	22	L	1	Jul.
	ipit		served	Date			1			.,		ľ					ľ			
	Precipitation	EMXP	Greatest Observed	Day	0.70	0.85	0.63	0.00	1.45	0.45	1.61	2 43	2.13	1.16	1.89	0.68	125	1	Σ	Σ
above sea leve		DPNP	Denart	from	Σ	-101	0.74	0.14	2.65	-2.87	0.89	0.40	0.42	-2.92	0.64	M	0 19	2	Σ	Σ
apove s		TPCP		Total	2.84X	2 62	2.44	0.14	5.77	1.46	5.15	500	20.02	1.35	4.22	2.07X	3.28	2	2.97X	39.87X
660 ft. a		DT00	_	Min <=0°	0	0	0	7	0	0	0		0	0	0	0	C		0	0
		DT32	of Days	Min <=32°	23	16	1	1	-	0	C	0	0	0	0	-	0		19	73
Elev.		DX32	Number of Days	Max <=32°	3	c		2	0	0	C	9	٥	0	0	0	C	7	0	3
		DT90	ž	Max >=90°	0	0	1		0	-	7		10	1	4	0	c	7	0	39
		٦	T	Low N	19	1		18	10	12	'n	7	31	25	7	23	20	07	16	Jan
ırolina		EMNP		Lowest	10	25	3 6	30	29	39	47		28	99	48	32	22	77	20	10
th Ca	(° F)	r	T	High	4	å	07	30	5	20	27	17	29	18	3	10	·	2	21	Aug
‡5, Nor		EMXT		Highest		75	2 2	80	83	06	90	G F	98	98	93	88	1		65	98
E STN	Temperature	CLDD	1	Degree	10		1	0	10	50	242	747	424	360	189	51	,	٦	0	1326
ON FIRE	Ter	HTDD	+	Degree Days	803	200	acc.	347	320	114	100	40	2	0	18	218		558	750	3736
LINGT		TNAO	+	from Normal	4.0	2.	4.2	4.1	-4.2	1 4		-3.3	0.2	9.0-	0.0	0.0	3.5	4.3	-0.7	9.0-
9, BUR		MTMM	_	Mean	0 00	20.0	44.8	53.6	54.4	62.7	7.50	71.3	78.4	76.4	70.4	50 5	0.00	46.1	40.6	58.1
36666/6		TMMM	_	Mean	Total 1	7.07	34.0	40.2	426	70 2	40.0	61.3	67.9	64.7	593	47.0	4.0	34.8	30.6	
311239		MANAYT	_	Mean	Max.	91.9	55.5	6.99	66.2	77.4		81.3	88.9	88.0	81.5	74.0	6.17	57.4	50.5	
Station: 311239/99999, BURLINGTON FIRE STN #5, North Cal	Date	+	Ciem-	1997	MODILI		2	3	V	-	n	9	7	α	0	9	01	11	12	Annual

Notes

(blank) Not reported

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subsequent monthly value. If TPCP = "M" accumulation began. The element TPCP accumulated amount value appears in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of S Precipitation amount is continuing to be accumulated. Total will be included in a would then be 00135S and the total precipitation, then a period of subsequent monthly value

> Dynamically generated Wed Jun 16 17:25:21 EDT 2004 via http://cdo.ncdc.noaa.gov/ancsum/ACS Data provided from the NCDC CDO System

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CLIMATOLOGICAL SUMMARY ANNUAL

151 Patton Avenue Asheville, North Carolina 28801 Federal Building National Climatic Data Center

244220/00000 BIIDI INGTON FIRE STN #5. North Carolina

Elev. 660 ft. above sea level

Lat. 36°04'N, Lon. 79°27'W

															•	•			1			
				Te	Temperature	ature	() E	_							_	recip	Precipitation		(Inches			
1	-	1111111	THOU	UTD	0010	FMXT		FMNP	F	DT90	DX32 D	DT32 DT00	TOO TPCP	CP DPNP	IP EMXP	а	TS	SNW M	MXSD	DP01	01 DP05	5 DP10
MMX	MMN	MINIM	NILO	0011	1				1	Ž		Days	-	Denart		Greatest Observed	ved	Snow	Snow, Sleet		Number of Days	of Days
Mean	Mean	Moon	Depart. from Normal	Heating Degree	Cooling	Highest	High	Lowest	Low N	Max	Max Min <=32° <=32°	Min Min <=0	Min <=0° Total		n nal Day		Date F	Total N Fall D	Max Max Depth Date	Max Date >=.10	10 >=.50	0 >=1.0
MdX.		_	5.6		+	72		17	2	0	0	17	0 6	6.23	2.73	1.12	16	X0.0	0	+	12	2
5.20					C			23	2	0	0	12	0	5.63	2.00	2.25	17	0.0	0	+	7	3
2002					,			20	14	0	0	6	9 0	6.52	2.64	2.33	19	0.0	0	\dashv	7	2
20.0	30.2						L	36	9	0	0	0	0	4.82	1.70	1.71	17	0.0	0	\dashv	7	4
70.4					_		17	47	9	3	0	0	0 4	4.57	0.24	1.13	56	0.0	0	+	7	2
79.5							28	47	80	15	0	0	0 2	2.23	-2.03	0.54	30	0.0	0		7	-
87.8							L	S.F.	17	20	c	c	0	0 80	-3.80	0.63	28	0.0	0		2	-
91.4								20	2.5	45	0	0	L	L	-3 91	0.26	17	0.0	0	H	2	0
89.2	67.3	78.3						000	17	7 77	0	0	\perp		0.80	3.00	4	0.0	0	\vdash	8	2
86.4	62.9	74.7	4.3	5	301	66		10	47	=	3	,			100	7 40	6	0	2	H	^	-
74.3	48.3	61.3	2.0	135	5 29	9 87	2	33	24	0	0	0	0		-1./6	1.10	2	0.0	E (\dagger	1 (
63.6				389		0 79	-	27	7	0	0	4	0	1.31	-1.76	0.36	15	0.0	0	+	9	0 1
56.4				586	4	4 79	80	23	27	0	3	15	0	4.90	1.44	1.20	13	0.0X	0	+	9 9	
70.0	ı		24	3119	1795	100	Aug	17	Jan	61	3	22	0 43	43.25	-1.71	3.00	Sep	X0.0	Σ	-	99	32 15

Notes

(blank) Not reported

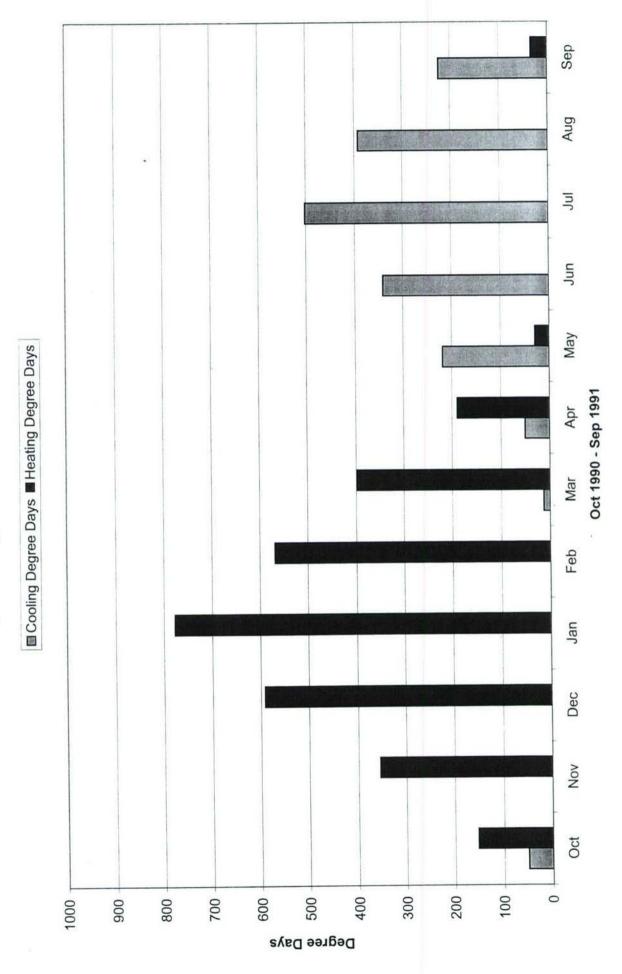
- + Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence. Used through December
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> Dynamically generated Mon Jun 21 16:24:44 EDT 2004 via http://cdo.ncdc.noaa.gov/ancsum/ACS Data provided from the NCDC CDO System

Monthly Heating & Cooling Degree Days

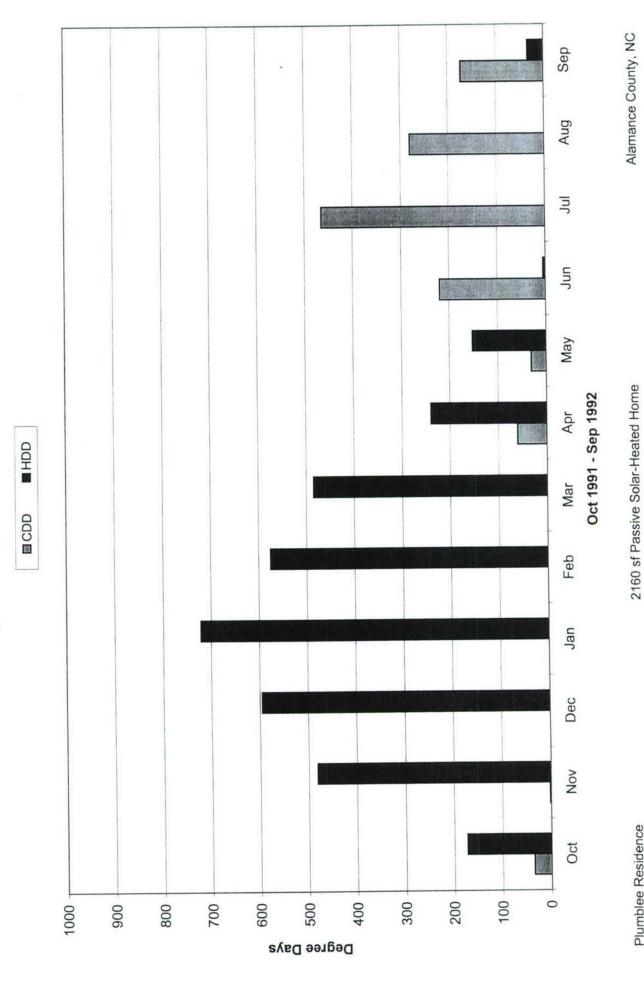


Alamance County, NC

2160 sf Passive Solar-Heated Home

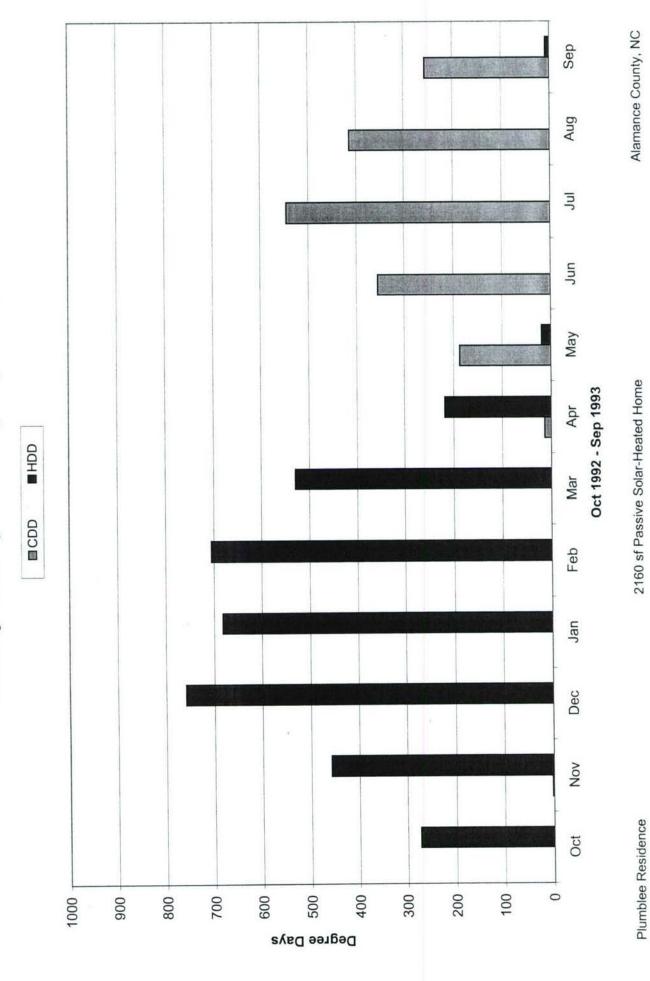
Plumblee Residence

Monthly Heating & Cooling Degree Days

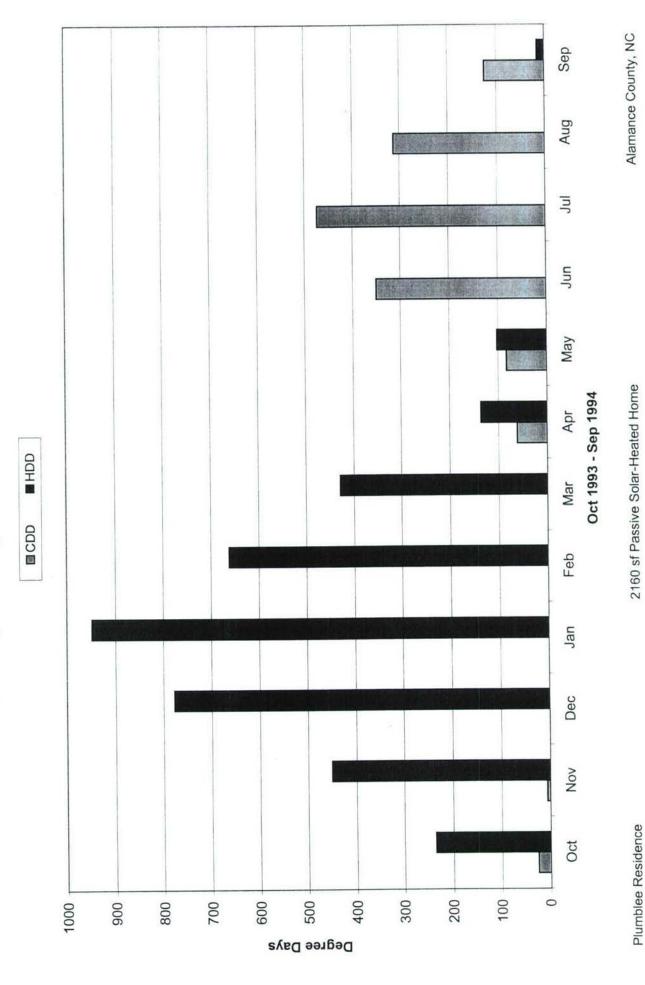


Plumblee Residence

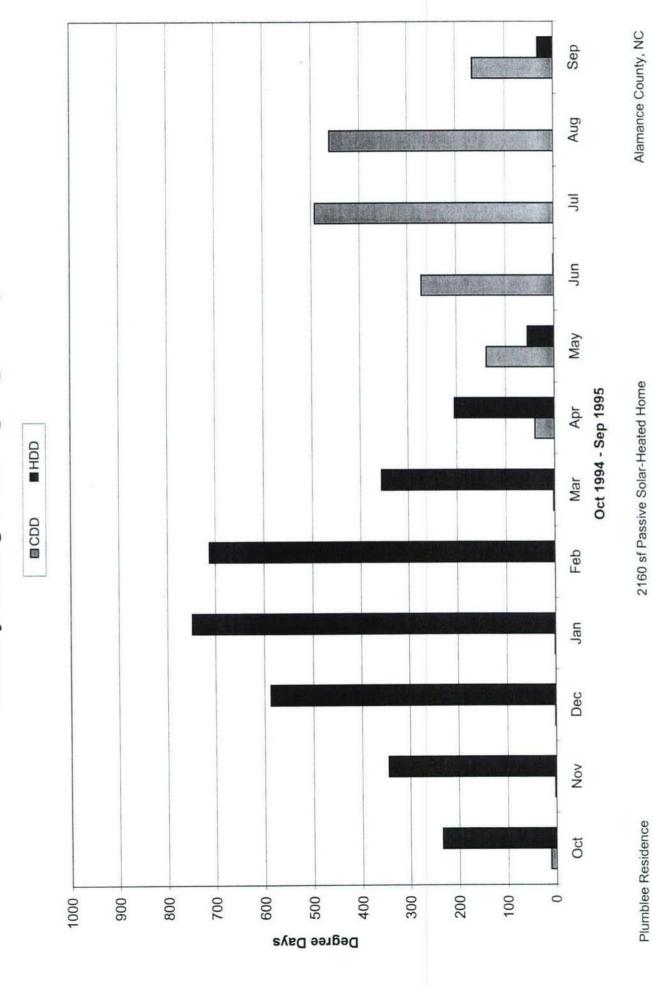
Monthly Heating & Cooling Degree Days



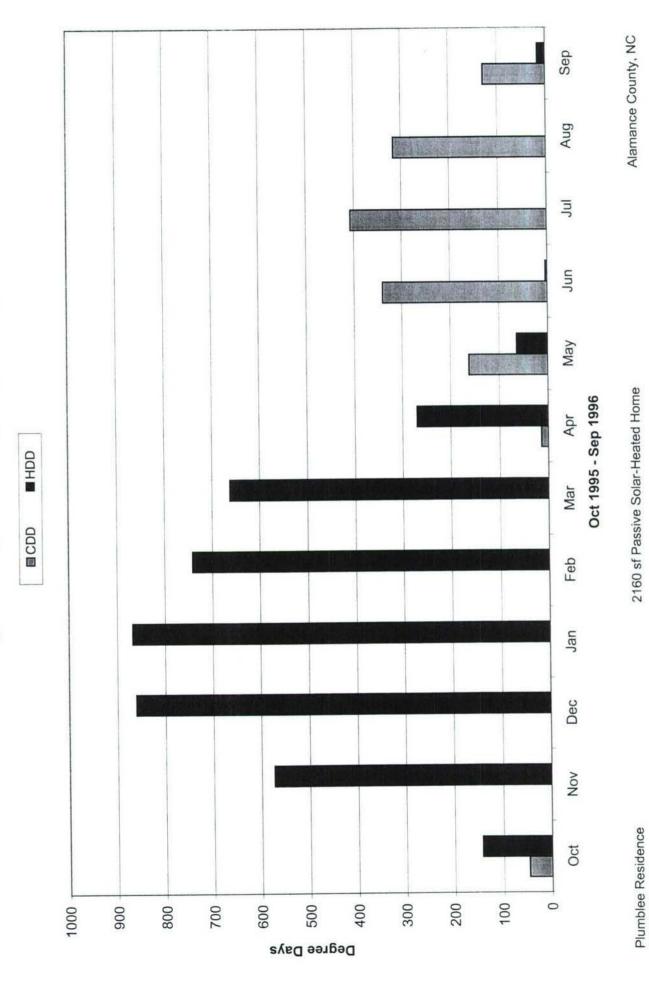
Monthly Heating & Cooling Degree Days



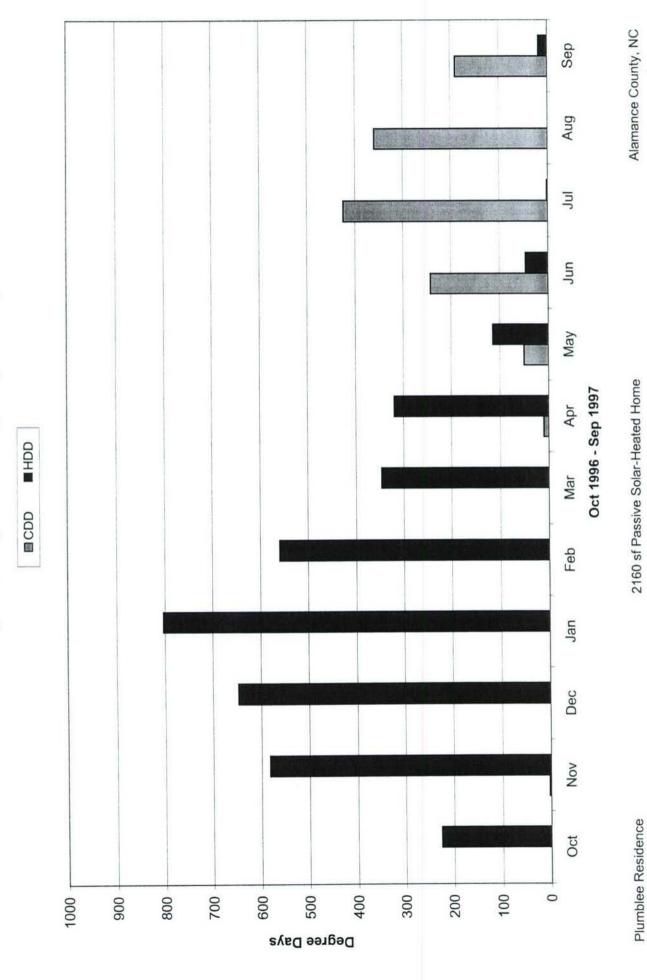
Monthly Heating & Cooling Degree Days



Monthly Heating & Cooling Degree Days



Monthly Heating & Cooling Degree Days



APPENDIX D

{Energy-10: Thermal Performance Simulations}

Jul 23, 2004 Energy-10 Summary Page Project Directory: C:\Program Files\Energy10v1_5\PROJ1 Project: PROJ2

riojecc. ricos		
	Energy Efficient Case	
Description:	8 / Saved	none
Scheme Number:	PLUMBLEELIB / Saved	-
Library Name:		_
Simulation status, Thermal/DI		
Comments:	EES by Harry Boody, PE	_
Weather file:	Grnsboro.et1	
Floor Area, ft ²	2160.0	
Surface Area, ft ²	5856.5	_
Volume, ft ³	18653.0	
Total Conduction UA, Btu/h-F	362.4	-
Average U-value, Btu/hr-ft2-1	0.062	(<u>-</u>
Wall Construction	2 x 4 cypress, R=14.5,etc	-
Roof Construction	shingle, attic, r-30, R=30.5	_
Floor type, insulation	Crawl Space, Reff=162.7,etc	-
Window Construction	2058 double, wood, U=0.48,etc	
Window Shading	36 deg lat plumblee,etc	-
Wall total gross area, ft2	1536	-
Roof total gross area, ft ²	2160	-
Ground total gross area, ft ²	2160	-
Window total gross area, ft ²	427	=
Windows (N/E/S/W:Roof)	5/7/13/4:0	-
Glazing name	double, U=0.49	-
Glazing name		
Operating parameters for zon HVAC system Rated Output (Heat/SCool/TCo Rated Air Flow/MOOA, cfm Heating thermostat Cooling thermostat Heat/cool performance Economizer?/type Duct leaks/conduction losses Peak Gains; IL, EL, HW, OT; W/f Added mass? Daylighting? Infiltration, in²	r Source Heat Pump/ER Backup ol), kBtu/h	
Results: Energy cost 2.020\$/Therm, Simulation dates Energy use, kBtu	01-Jan to 31-Dec 52783	-) 00-Jan to 00-Jan NA
Energy cost, \$	1067	NA
Saved by daylighting, kWh	-	NA
Total Electric, kWh	15469	NA
Internal/External lights,	Wh 915/0	NA
Heating/Cooling/Fan, kWh	4059/2/18/429	NC
Elec. Res./Heat Pump, kWh	3083/976	NA
Hot water/Other, kWh	6559/788	NC
Peak Electric, kW	15.6	NA
Fuel, hw/heat/total, kBtu	0/0/0	NC
Emissions, CO2/SO2/NOx, lbs	20790/122/63	NA
Emissions, cozysozynoz, ibs	197913	0

Construction Costs

Life-Cycle Cost

282963

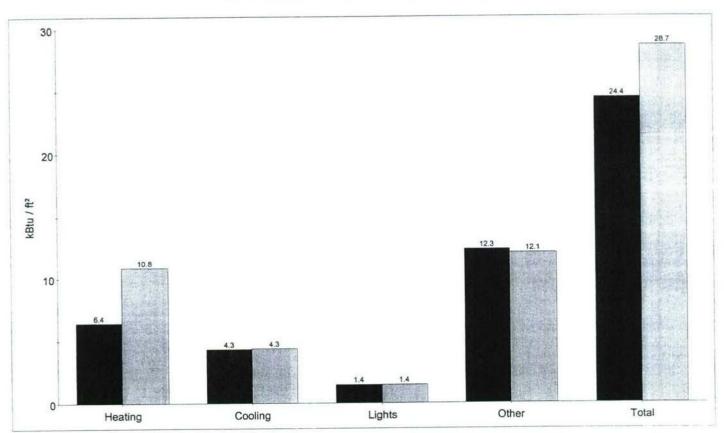
248386

escription:	Energy Efficient Case	Gas Furnace Case
Scheme Number:	8 / Saved	9 / Saved
Library Name:	PLUMBLEELIB / Saved	PLUMBLEELIB / Saved
Simulation status, Thermal/DL	valid/NA	valid/NA
Comments:	EES by Harry Boody, PE EE	S by Harry Boody, PE
Weather file:	Grnsboro.et1	Grnsboro.et1
Floor Area, ft ²	2160.0	2160.0
Surface Area, ft ²	5856.5	5856.5
Volume, ft ³	18653.0	18653.0
Total Conduction UA, Btu/h-F	362.4	362.4
Average U-value, Btu/hr-ft2-F		0.062
Wall Construction		cypress, R=14.5,etc
Roof Construction	shingle, attic, r-30, R=30.5 shir	
Floor type, insulation	Crawl Space, Reff=162.7,etc Craw	Space, Reff=162.7,etc
_Window Construction	2058 double, wood, U=0.48, etc2058	double, wood, U=0.48,etc
Window Shading	36 deg lat plumblee, etc 36	deg lat plumblee, etc
Wall total gross area, ft ²	1536	1536
Roof total gross area, ft ²	2160	2160
Ground total gross area, ft ²	2160	2160
Window total gross area, ft ²	427	427
Windows (N/E/S/W:Roof)	5/7/13/4:0	5/7/13/4:0
Glazing name	double, U=0.49	double, U=0.49
Grazing name		*
Operating parameters for zone	. 1	
HVAC system Air	Source Heat Pump/ER Backup DX (Cooling with Gas Furnace
Rated Output (Heat/SCool/TCoo		38/25/33
Rated Air Flow/MOOA, cfm	1320/0	1210/0
Heating thermostat	68.0 °F, no setback	68.0 °F, no setback
Cooling thermostat	77.0 °F, no setup	77.0 °F, no setup
Heat/cool performance	COP=3.0, EER=10.1	eff=80, EER=10.1
Economizer?/type	no/NA	no/NA
Duct leaks/conduction losses,	total % 11/10	11/10
Peak Gains; IL, EL, HW, OT; W/ft	0.20/0.04/2.08/0.25	0.20/0.04/2.08/0.25
Added mass?	none	none
Daylighting?	no	no
Infiltration, in ²	ACH=0.2	ACH=0.2
Ellitatoro de Company		
_Results:		
Energy cost 2.020\$/Therm,0	.069\$/kWh,0.000\$/kW 2.020\$/Therm	,0.069\$/kWh,0.000\$/kW
Simulation dates	01-Jan to 31-Dec	01-Jan to 31-Dec
Energy use, kBtu	52783	61933
Energy cost, \$	1067	1251
Saved by daylighting, kWh	-	NA
Total Electric, kWh	15469	4727
Internal/External lights, kV	Wh 915/0	915/0
■ Heating/Cooling/Fan, kWh	4059/2718/429	0/2744/280
Elec. Res./Heat Pump, kWh	3083/976	0/0
Hot water/Other, kWh	6559/788	0/788
Peak Electric, kW	15.6	3.7
Fuel, hw/heat/total, kBtu	0/0/0	22383/23420/45803
Emissions, CO2/SO2/NOx, lbs	20790/122/63	11763/42/25
Construction Costs	197913	200474
Life-Cycle Cost	250873	257916

Life-Cycle Cost

PROJ2 - ANNUAL ENERGY USE

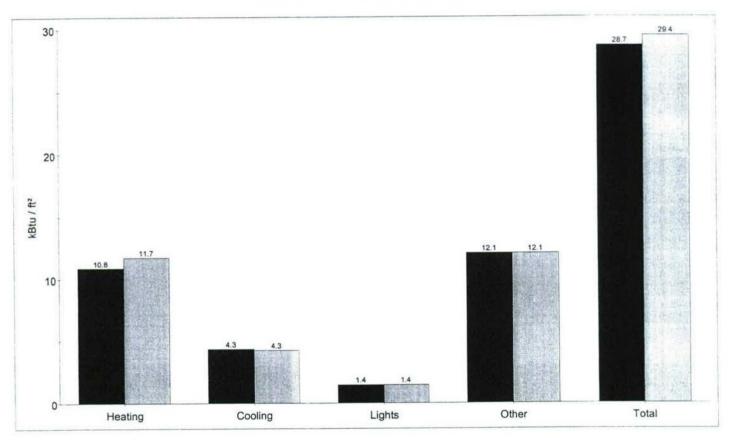
■ Energy Efficient Case ■ Gas Furnace Case



escription:	Gas Furnace Case	Orientation 15 East Case
Scheme Number:	9 / Saved	28 / Saved
Library Name:	PLUMBLEELIB / Saved	PLUMBLEELIB / Saved
mimulation status, Thermal/DL		valid/NA
comments:	EES by Harry Boody, PE	EES by Harry Boody, PE
Weather file:	Grnsboro.et1	Grnsboro.et1
Floor Area, ft ²	2160.0	2160.0
Surface Area, ft ²	5856.5	5856.5
olume, ft ³	18653.0	18653.0
Total Conduction UA, Btu/h-F	362.4	362.4
Average U-value, Btu/hr-ft2-F		0.062
Vall Construction	2 x 4 cypress, R=14.5,etc	2 x 4 cypress, R=14.5,etc
Roof Construction	shingle, attic, r-30, R=30,	.5 shingle, attic, r-30, R=30.5
Floor type, insulation	Crawl Space. Reff=162.7.etc	Crawl Space, Reff=162.7,etc
_Window Construction	2058 double, wood, U=0.48.6	etc2058 double, wood, U=0.48,etc
Vindow Constitution	36 deg lat plumblee, etc	36 deg lat plumblee,etc
Wall total gross area, ft ²	1536	1536
Roof total gross area, ft ²	2160	2160
Ground total gross area, ft ²	2160	2160
Window total gross area, ft ²	427	427
Window total gloss area, it	5/7/13/4:0	5/7/13/4:0
Glazing name	double, U=0.49	double, U=0.49
Glazing name	double, 0 0.45	404220, 0 0.13
operating parameters for zone	. 1	
HVAC system DX	Cooling with Gas Furnace	DX Cooling with Gas Furnace
Rated Output (Heat/SCool/TCoo	11) kBtu/h 38/25/33	38/25/34
Rated Air Flow/MOOA, cfm	1210/0	1232/0
Heating thermostat	68.0 °F, no setback	68.0 °F, no setback
Cooling thermostat	77.0 °F, no setup	77.0 °F, no setup
Heat/cool performance	eff=80,EER=10.1	
Economizer?/type	no/NA	no/NA
Duct leaks/conduction losses,		11/10
Peak Gains; IL, EL, HW, OT; W/ft	2 0.20/0.04/2.08/0.25	0.20/0.04/2.08/0.25
Added mass?	none	none
Daylighting?	no	no
Infiltration, in ²	ACH=0.2	ACH=0.2
_Results:		
Energy cost 2.020\$/Therm,0	.069\$/kWh,0.000\$/kW 2.020\$	5/Therm, 0.069\$/kWh, 0.000\$/kW
Simulation dates	01-Jan to 31-Dec	01-Jan to 31-Dec
Energy use, kBtu	61933	63611
Energy cost, \$	1251	1285
Saved by daylighting, kWh	-	NA
Fotal Electric, kWh	4727	4678
Internal/External lights, kW	Wh 915/0	915/0
■ Heating/Cooling/Fan, kWh	0/2744/280	0/2692/283
Hot water/Other, kWh	0/788	0/788
■ Peak Electric, kW	3.7	3.7
Fuel, hw/heat/total, kBtu	22383/23420/45803	22383/25264/47647
Emissions, CO2/SO2/NOx, 1bs	11763/42/25	11915/42/25
Construction Costs	203458	200622
Life-Cycle Cost	257916	259123
Company of the Compan		

PROJ2 - ANNUAL ENERGY USE





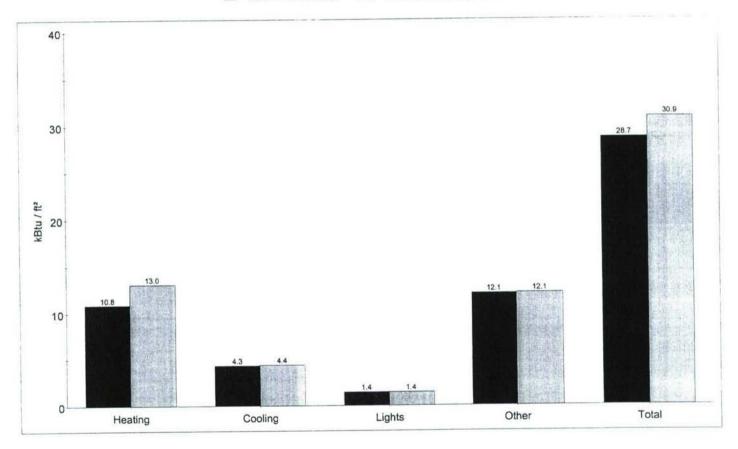
Jul 26, 2004

Project Directory: C:\Program Files\Energy10v1_5\PROJ1 nergy-10 Summary Page roject: PROJ2

escription:	Gas Furnace Case	Orientation 30 East Case
scheme Number:	9 / Saved	12 / Saved
Library Name:	PLUMBLEELIB / Saved	PLUMBLEELIB / Saved
mimulation status, Thermal/DI	valid/NA	valid/NA
omments:	EES by Harry Boody, PE	EES by Harry Boody, PE
weather file:	Grnsboro.et1	Grnsboro.et1
Floor Area, ft ²	2160.0	2160.0
Turface Area, ft ²	5856.5	5856.5
folume, ft ³	18653.0	18653.0
Total Conduction UA, Btu/h-F	362.4	362.4
Average U-value, Btu/hr-ft2-F	0.062	0.062
all Construction	2 x 4 cypress, R=14.5,etc	2 x 4 cypress, R=14.5,etc
oof Construction	shingle, attic, r-30, R=30.5	shingle, attic, r-30, R=30.5
Floor type insulation	Crawl Space, Reff=162.7,etc	Crawl Space, Reff=162.7,etc
Window Construction	2058 double, wood, U=0.48,et	c2058 double, wood, U=0.48,etc
indow Shading	36 deg lat plumblee,etc	36 deg lat plumblee, etc
all total gross area, ft ²	1536	1536
Roof total gross area, ft ²	2160	2160
Ground total gross area, ft ²	2160	2160
findow total gross area, ft ²	427	427
findow total gloss area, it	5/7/13/4:0	5/7/13/4:0
Glazing name	double, U=0.49	double, U=0.49
GIAZING NAME	double, o oils	, , , , , , , , , , , , , , , , , , , ,
perating parameters for zone	1	
AVAC system D	X Cooling with Gas Furnace D	X Cooling with Gas Furnace
Rated Output (Heat/SCool/TCoo	31 kB+11/h 38/25/33	38/25/34
		1249/0
leating thermostat	1210/0 68.0 °F, no setback 77.0 °F, no setup	68.0 °F, no setback
Cooling thermostat	77.0 °F, no setup	77.0 °F, no setup
Heat/cool performance	eff=80,EER=10.1	eff=80, EER=10.1
conomizer?/type	no/NA	no/NA
ouct leaks/conduction losses,		11/10
Peak Gains; IL, EL, HW, OT; W/ft	2 0.20/0.04/2.08/0.25	0.20/0.04/2.08/0.25
Added mass?	none	none
Daylighting?	no	no
infiltration, in ²	ACH=0.2	ACH=0.2
illiticiación, in	11011-012	
_Results:		
Energy cost 2 0205/Therm 0	.069\$/kWh,0.000\$/kW 2.020\$/	Therm. 0.069\$/kWh. 0.000\$/kW
Simulation dates	01-Jan to 31-Dec	01-Jan to 31-Dec
Energy use, kBtu	61933	66806
Energy cost, \$	1251	1350
Saved by daylighting, kWh	-	NA
otal Electric, kWh	4727	4777
Internal/External lights, k		915/0
■ Heating/Cooling/Fan, kWh	0/2744/280	0/2773/301
Hot water/Other, kWh	0/788	0/788
Peak Electric, kW	3.7	3.7
Fuel, hw/heat/total, kBtu	22383/23420/45803	22383/28124/50507
Emissions, CO2/SO2/NOx, 1bs	11763/42/25	12385/43/26
Construction Costs	203458	200711
Life-Cycle Cost	257916	261133
Dire Cycle Cost		

PROJ2 - ANNUAL ENERGY USE

Gas Furnace Case Orientation 30 East Case



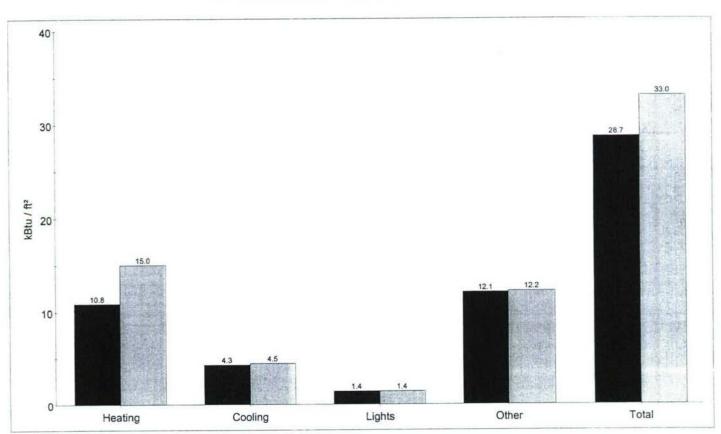
Jul 27, 2004

Project Directory: C:\Program Files\Energy10v1_5\PROJ1 roject: PROJ2

escription:	Gas Furnace Case	Orientation 45 East Case
Scheme Number:	9 / Saved	
Library Name:	PLUMBLEELIB / Saved	PLUMBLEELIB / Saved
mimulation status, Thermal/DI	valid/NA	valid/NA
omments:	EES by Harry Boody, PE	EES by Harry Boody, PE
Weather file:	Grnsboro.et1	Grnsboro.et1
Floor Area, ft ²	2160.0	2160.0
urface Area, ft ²	5856.5	5856.5
olume, ft ³	18653.0	18653.0
Total Conduction UA, Btu/h-F	362.4	362.4
Average U-value, Btu/hr-ft2-F		0.062
all Construction	2 x 4 cypress, R=14.5, etc	
oof Construction	chingle attic r-30 R=30	.5 shingle, attic, r-30, R=30.5
	Crawl Space Reff=162 7 et	c Crawl Space, Reff=162.7,etc
	2058 double wood II=0 48	etc2058 double, wood, U=0.48, etc
Window Construction	36 deg lat plumblee, etc	36 deg lat plumblee, etc
Vindow Shading	1536	1536
Wall total gross area, ft ²	2160	2160
Roof total gross area, ft ²		2160
Fround total gross area, ft2	2160	
lindow total gross area, ft ²	427	427
Windows (N/E/S/W:Roof)	5/7/13/4:0	5/7/13/4:0
Glazing name	double, U=0.49	double, U=0.49
William or an agent and the second of the se		
operating parameters for zone	1	and a second second
HVAC system D	K Cooling with Gas Furnace	DX Cooling with Gas Furnace
Rated Output (Heat/SCool/TCoo	ol), kBtu/h 38/25/33	40/30/40
Rated Air Flow/MOOA,cfm	1210/0	1614/0
leating thermostat	68.0 °F, no setback	
Cooling thermostat	77.0 °F, no setup	
Heat/cool performance	eff=80,EER=10.1	
Conomizer?/type	no/NA	
ouct leaks/conduction losses,	total % 11/10	
Peak Gains; IL, EL, HW, OT; W/ft	0.20/0.04/2.08/0.25	0.20/0.04/2.08/0.25
_Added mass?	none	none
Daylighting?	no	no
Infiltration, in ²	ACH=0.2	ACH=0.2
TOTAL TOTAL SAMPLE AND ARREST BELLEVILLE		
_Results:		
Energy cost 2.020\$/Therm,0	.069\$/kWh,0.000\$/kW 2.020	\$/Therm,0.069\$/kWh,0.000\$/kW
Simulation dates	01-Jan to 31-Dec	
Energy use, kBtu	61933	71326
Energy cost, \$	1251	1441
Saved by daylighting, kWh	-	NA
Total Electric, kWh	4727	4880
Internal/External lights, ki		915/0
■ Heating/Cooling/Fan, kWh	0/2744/280	0/2823/354
Hot water/Other, kWh	0/788	0/788
Peak Electric, kW	3.7	3.7
Fuel, hw/heat/total, kBtu	22383/23420/45803	22383/32292/54675
Emissions, CO2/SO2/NOx, 1bs	11763/42/25	13015/45/27
Construction Costs	203458	202620
Life-Cycle Cost	259123	261133
Lite-Cycle Cost	233123	

PROJ2 - ANNUAL ENERGY USE

Gas Furnace Case Orientation 45 East Case

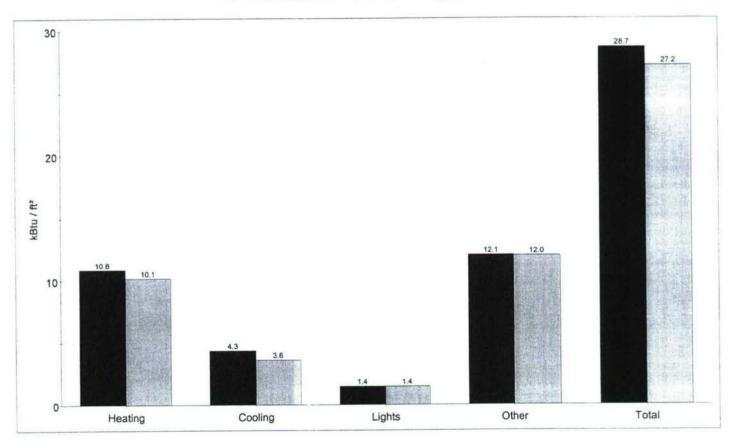


Jul 26, 2004 nergy-10 Summary Page roject: PROJ2 Project Directory: C:\Program Files\Energy10v1_5\PROJ1

escription:	Gas Furnace Case	South-Facing low-e Case
cheme Number:	9 / Saved	30 / Saved
Library Name:	PLUMBLEELIB / Saved	modified / Saved
mimulation status, Thermal/DL	valid/NA	valid/NA
omments:	EES by Harry Boody, PE	EES by Harry Boody, PE
weather file:	Grnsboro.et1	Grnsboro.et1
Floor Area, ft ²	2160.0	2160.0
Turface Area, ft ²	5856.5	5856.5
olume, ft ³	18653.0	18653.0
Total Conduction UA, Btu/h-F	362.4	306.8
Average U-value, Btu/hr-ft2-F	0.062	0.052
mall Construction	2 x 4 cypress, R=14.5, etc	2 x 4 cypress, R=14.5,etc
oof Construction	shingle, attic, r-30, R=30	.5 shingle, attic, r-30, R=30.5
Floor type, insulation	Crawl Space, Reff=162.7, et	c Crawl Space, Reff=162.7,etc
Window Construction	2058 double, wood, U=0.48,	etc2058 double, wood, U=0.28,etc
indow Shading	36 deg lat plumblee, etc	36 deg lat plumblee, etc
all total gross area, ft ²	1536	1536
Roof total gross area, ft ²	2160	2160
Ground total gross area, ft ²	2160	2160
lindow total gross area, ft ²	427	427
lindows (N/E/S/W:Roof)	5/7/13/4:0	5/7/13/4:0
Glazing name	double, U=0.49	double low-e, U=0.26
Glazing name	doddio, o cito	
perating parameters for zone	. 1	
VAC system D	Cooling with Gas Furnace	DX Cooling with Gas Furnace
Rated Output (Heat/SCool/TCoo	11 kBtu/h 38/25/33	34/23/31
Rated Output (Near/Scool/Took	1210/0	1119/0
leating thermostat	68.0 °F, no setback	68.0 °F, no setback
cooling thermostat	77.0 °F, no setup	
Heat/cool performance	eff=80,EER=10.1	
Conomizer?/type	no/NA	
ouct leaks/conduction losses,		11/10
Peak Gains; IL, EL, HW, OT; W/ft	2 0 20/0 04/2 08/0.25	0.20/0.04/2.08/0.25
Added mass?	none	none
	no	no
Daylighting? Infiltration, in ²	ACH=0.2	ACH=0.2
.nilitration, in	11011 012	
Results:		
Freray cost 2 020\$/Therm.0	.0698/kWh.0.0008/kW 2.020	\$/Therm,0.069\$/kWh,0.000\$/kW
Simulation dates	01-Jan to 31-Dec	01-Jan to 31-Dec
Energy use, kBtu	61933	58727
Energy cost, \$	1251	1187
Saved by daylighting, kWh	5 =	NA
Total Electric, kWh	4727	4232
Internal/External lights, k	Wh 915/0	915/0
■ Heating/Cooling/Fan, kWh	0/2744/280	0/2288/240
Hot water/Other, kWh	0/788	0/788
Peak Electric, kW	3.7	3.4
Fuel, hw/heat/total, kBtu	22383/23420/45803	22383/21905/44288
Emissions, CO2/SO2/NOx, 1bs	11763/42/25	10918/38/23
Construction Costs	203458	199623
Life-Cycle Cost	257916	254460
Lilo ojono cose		

PROJ2 - ANNUAL ENERGY USE

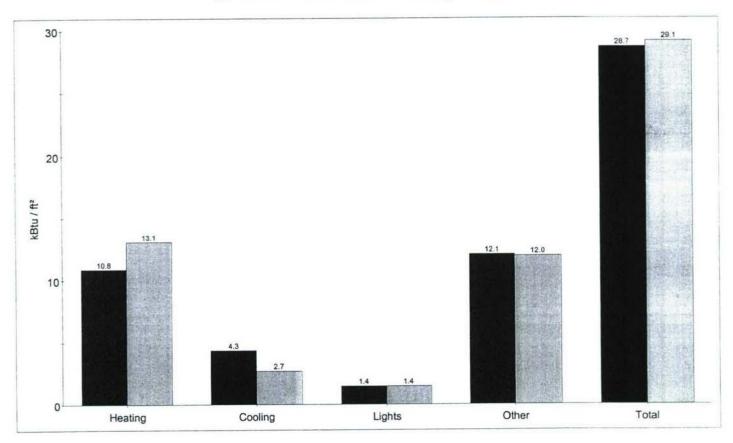
Gas Furnace Case South-Facing low-e Case



escription:	Gas Furnace Case	8 South-F	acing low-e Case
Scheme Number:	9 / Saved		31 / Saved
Library Name:	PLUMBLEELIB / Saved		ELOWELIB / Saved
mimulation status, Thermal/DL	valid/NA		valid/NA
comments:	EES by Harry Boody, PE	EES by	Harry Boody, PE
Weather file:	Grnsboro.etl		Grnsboro.et1
_Floor Area, ft2	2160.0		2160.0
Surface Area, ft2	5856.5		5856.5
Volume, ft ³	18653.0		18653.0
Total Conduction UA, Btu/h-F	362.4		281.0
Average U-value, Btu/hr-ft2-F	0.062		0.048
Wall Construction	2 x 4 cypress, R=14.5,etc	2 x 4 cyr	oress, R=14.5,etc
Roof Construction	shingle, attic, r-30, R=30		attic, r-30, R=30.5
Floor type, insulation	Crawl Space, Reff=162.7, et		pace, Reff=162.7,etc
Window Construction	2058 double, wood, U=0.48,	etc2058 dou	ible, wood, U=U.28,etc
Vindow Shading	36 deg lat plumblee, etc	36 deg	lat plumblee, etc
Wall total gross area, ft ²	1536		1536
Roof total gross area, ft ²	2160		2160
Ground total gross area, ft ²	2160		2160 299
Window total gross area, ft ²	427		5/7/9/4:0
Windows (N/E/S/W:Roof)	5/7/13/4:0		
Glazing name	double, U=0.49	dour	ole low-e, U=0.26
perating parameters for zone	Carlina with Car European	DV Cooling	with Cas Furnace
	Cooling with Gas Furnace 38/25/33	DA COOTING	32/22/29
Rated Output (Heat/SCool/TCoo	1210/0		1030/0
Rated Air Flow/MOOA,cfm	68.0 °F, no setback	68	.0 °F, no setback
Heating thermostat	77.0 °F, no setup		77.0 °F, no setup
Cooling thermostat	eff=80, EER=10.1		eff=80,EER=10.1
Heat/cool performance Economizer?/type	no/NA		no/NA
Duct leaks/conduction losses,			11/10
Peak Gains; IL, EL, HW, OT; W/ft	2 0 20/0 04/2 08/0.25		20/0.04/2.08/0.25
_Added mass?	none		none
Daylighting?	no		no
Infiltration, in ²	ACH=0.2		ACH=0.2
milliciación, in	11011 0.2		
_Results:			
Energy cost 2.020\$/Therm,0	0695/kWh.0.0005/kW 2.020	S/Therm.0.0	69\$/kWh,0.000\$/kW
Simulation dates	01-Jan to 31-Dec		01-Jan to 31-Dec
Energy use, kBtu	61933		62957
Energy cost, \$	1251		1272
Saved by daylighting, kWh	-		NA
Total Electric, kWh	4727		3612
Internal/External lights, kV	Vh 915/0		915/0
■ Heating/Cooling/Fan, kWh	0/2744/280		0/1693/217
Hot water/Other, kWh	0/788		0/788
Peak Electric, kW	3.7		3.1
Fuel, hw/heat/total, kBtu	22383/23420/45803		22383/28247/50630
Emissions, CO2/SO2/NOx, 1bs	11763/42/25		10834/34/21
Construction Costs	203458		198945
Life-Cycle Cost	257916		255458

PROJ2 - ANNUAL ENERGY USE

■ Gas Furnace Case
■ 8 South-Facing low-e Case



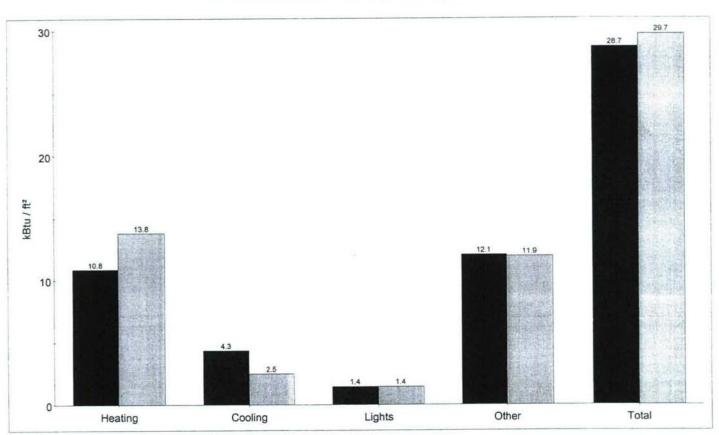
escription: Gas Furnace Case 6 South-Facing low-e Case 32 / Saved Scheme Number: 9 / Saved PLUMBLEELIB / Saved PLBLELOWELIB / Saved Library Name: valid/NA valid/NA Simulation status, Thermal/DL Comments: EES by Harry Boody, PE EES by Harry Boody, PE Grnsboro.et1 Grnsboro.et1 Weather file: 2160.0 Floor Area, ft² 2160.0 5856.5 5856.5 Surface Area, ft² Volume, ft³ 18653.0 18653.0 362.4 274.9 Total Conduction UA, Btu/h-F Average U-value, Btu/hr-ft2-F 0.062 2 x 4 cypress, R=14.5,etc 2 x 4 cypress, R=14.5,etc shingle, attic, r-30, R=30.5 shingle, attic, r-30, R=30.5 Crawl Space, Reff=162.7,etc Crawl Space, Reff=162.7,etc Wall Construction Roof Construction Floor type, insulation 2058 double, wood, U=0.48, etc2058 double, wood, U=0.28, etc Window Construction 36 deg lat plumblee, etc 36 deg lat plumblee, etc Window Shading Wall total gross area, ft² 1536 1536 2160 2160 Roof total gross area, ft2 2160 Ground total gross area, ft2 2160 Window total gross area, ft² Windows (N/E/S/W:Roof) 270 427 5/7/7/4:0 5/7/13/4:0 double low-e, U=0.26 double, U=0.49 Glazing name Operating parameters for zone 1 DX Cooling with Gas Furnace DX Cooling with Gas Furnace HVAC system 31/21/28 Rated Output (Heat/SCool/TCool), kBtu/h 38/25/33 1010/0 1210/0 Rated Air Flow/MOOA,cfm 68.0 °F, no setback 77.0 °F, no setup 68.0 °F, no setback 77.0 °F, no setup Heating thermostat Cooling thermostat eff=80,EER=10.1 eff=80, EER=10.1 Heat/cool performance no/NA no/NA Economizer?/type 11/10 Duct leaks/conduction losses, total % 11/10 0.20/0.04/2.08/0.25 Peak Gains; IL, EL, HW, OT; W/ft² 0.20/0.04/2.08/0.25 none none Added mass? no no Daylighting? Infiltration, in² ACH=0.2 ACH=0.2 Results: Energy cost 2.020\$/Therm,0.069\$/kWh,0.000\$/kW 2.020\$/Therm,0.069\$/kWh,0.000\$/kW 01-Jan to 31-Dec Simulation dates 01-Jan to 31-Dec 64148 61933 Energy use, kBtu 1296 1251 Energy cost, \$ NA Saved by daylighting, kWh 4727 3499 Total Electric, kWh 915/0 915/0 Internal/External lights, kWh 0/2744/280 0/1582/214 Heating/Cooling/Fan, kWh 0/788 0/788 Hot water/Other, kWh 3.7 Peak Electric, kW Fuel, hw/heat/total, kBtu Emissions, CO2/SO2/NOx, lbs Construction Costs 22383/29825/52208 22383/23420/45803 11763/42/25 10868/33/21

Life-Cycle Cost

203458 257916

198785

PROJ2 - ANNUAL ENERGY USE



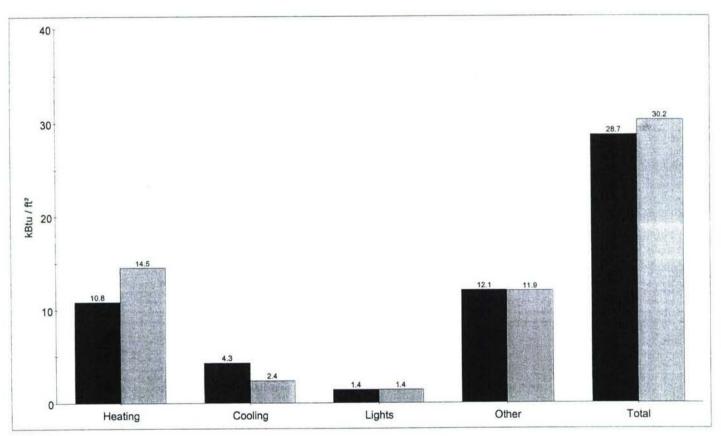
Jul 27, 2004

Project Directory: C:\Program Files\Energy10v1_5\PROJ1

Description:	Gas Furnace Case	4 South-Facing low-e Case	
Scheme Number:	9 / Saved	36 / Saved	
Library Name:	PLUMBLEELIB / Saved	PLBLELOWELIB / Saved	
Bimulation status, Thermal/DL	valid/NA	valid/NA	
Comments:	EES by Harry Boody, PE	EES by Harry Boody, PE	
Weather file:	Grnsboro.et1	Grnsboro.etl	
Floor Area, ft ²	2160.0	2160.0	
Surface Area, ft ²	5856.5	5856.5	
/olume, ft ³	18653.0	18653.0	
Total Conduction UA, Btu/h-F		269.2	
Average U-value, Btu/hr-ft2-F	0.062	0.046	
Wall Construction	2 x 4 cypress, R=14.5, etc	2 x 4 cypress, R=14.5, etc	-
	shingle, attic, r-30, R=30	0.5 shingle, attic, r-30, R=30.	5
	Crawl Space, Reff=162.7, et	c Crawl Space, Reff=162.7, etc	0 00
		etc2028 double low-e, wood, U=	0.30,etc
Window Shading	36 deg lat plumblee, etc		
Wall total gross area, ft ²	1536	1536	
Roof total gross area, ft ²	2160	2160	
Ground total gross area, ft ²	2160	2160 244	
Window total gross area, ft ²	427		
Windows (N/E/S/W:Roof)	5/7/13/4:0		
Glazing name	double, U=0.49	double 10w-e, 0-0.26	
Rated Output (Heat/SCool/TCoo	Cooling with Gas Furnace 1),kBtu/h 38/25/33 1210/0 68.0 °F, no setback 77.0 °F, no setup eff=80,EER=10.1 no/NA total % 11/10	77.0 °F, no setup eff=80,EER=10.1 no/NA 11/10 0.20/0.04/2.08/0.25 none	
Simulation dates Energy use, kBtu Energy cost, \$ Saved by daylighting, kWh Total Electric, kWh Internal/External lights, kWh Heating/Cooling/Fan, kWh Hot water/Other, kWh Peak Electric, kW Fuel, hw/heat/total, kBtu Emissions, CO2/SO2/NOx, lbs	01-Jan to 31-Dec 61933 1251 - 4727	\$/Therm,0.069\$/kWh,0.000\$/kW 01-Jan to 31-Dec 65331 1320 NA 3402 915/0 0/1488/212 0/788 2.9 22383/31338/53721 10917/33/21	
Construction Costs Life-Cycle Cost	250494	256222	
LLLO OJULO COOL			

PROJ2 - ANNUAL ENERGY USE

Gas Furnace Case 4 South-Facing low-e Case

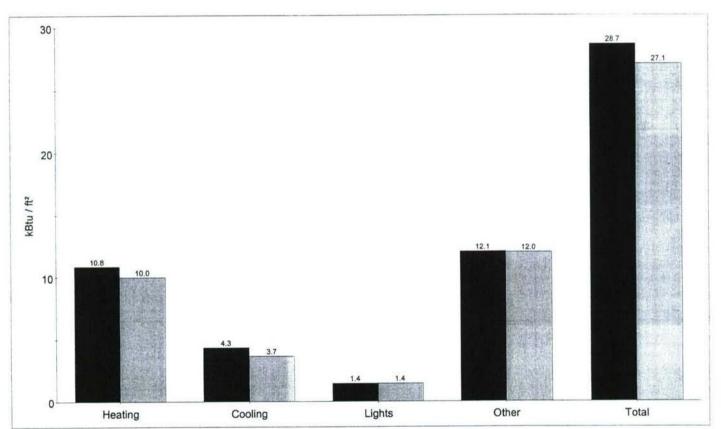


nergy-10 Summary Page roject: PROJ2 Project Directory: C:\Program Files\Energy10v1_5\PROJ1

escription:	Gas Furnace Case	Minimal Glazing Case
Scheme Number:	9 / Saved	35 / Saved
Library Name:	PLUMBLEELIB / Saved	obsolete / Not Saved
mimulation status, Thermal/DL	valid/NA	valid/NA
omments:	EES by Harry Boody, PE	EES by Harry Boody, PE
Weather file:	Grnsboro.et1	Grnsboro.et1
Floor Area, ft ²	2160.0	2160.0
urface Area, ft ²	5856.5	5856.5
'olume, ft ³	18653.0	18653.0
Total Conduction UA, Btu/h-F	362.4	337.0
Average U-value, Btu/hr-ft2-F	0.062	0.058
all Construction	2 x 4 cypress, R=14.5, etc 2	x 4 cypress, R=14.5,etc
oof Construction	shingle, attic, r-30, R=30.5	shingle, attic, r-30, R=30.5
Floor type, insulation	Crawl Space, Reff=162.7,etc	Crawl Space, Reff=162.7,etc
Window Construction	2058 double, wood, U=0.48,etc	2058 double, wood, U=0.48,etc
lindow Shading	36 deg lat plumblee, etc	36 deg lat plumblee, etc
Wall total gross area, ft2	1536	1536
Roof total gross area, ft2	2160	2160
Ground total gross area, ft2	2160	2160
Window total gross area, ft ²	427	325
Vindows (N/E/S/W:Roof)	5/7/13/4:0	2/4/13/2:0
Glazing name	double, U=0.49	double, U=0.49
perating parameters for zone	1	
VAC system D	X Cooling with Gas Furnace DX	Cooling with Gas Furnace
Rated Output (Heat/SCool/TCoo	ol), kBtu/h 38/25/33	35/22/29
- I Di - Fland MOOD ofm	1210/0	1054/0
Heating thermostat	68.0 °F, no setback	68.0 °F, no setback
Cooling thermostat	77.0 °F, no setup	77.0 °F, no setup
Heat/cool performance	eff=80, EER=10.1	eff=80,EER=10.1
conomizer?/type	no/NA	no/NA
buct leaks/conduction losses.	, total % 11/10	11/10
Peak Gains; IL, EL, HW, OT; W/f	1.20/0.04/2.08/0.25	0.20/0.04/2.08/0.25
Added mass?	none	none
Daylighting?	no	no
Infiltration, in ²	ACH=0.2	ACH=0.2
educations and internal electricity		
_Results:		0 0000 (HWH 0 0000 (HW
Energy cost 2.020\$/Therm,0	0.069\$/kWh,0.000\$/kW 2.020\$/T	01-Jan to 31-Dec
Simulation dates	01-Jan to 31-Dec	58564
Energy use, kBtu	61933	
Energy cost, \$	1251	1183 NA
Saved by daylighting, kWh		4267
Total Electric, kWh	4727	915/0
Internal/External lights, k	Wh 915/0	0/2328/236
 Heating/Cooling/Fan, kWh 	0/2744/280	0/2328/236
Hot water/Other, kWh	0/788	3.3
Peak Electric, kW	3.7	22383/21619/44002
Fuel, hw/heat/total, kBtu	22383/23420/45803	10932/39/23
Emissions, CO2/SO2/NOx, lbs	11763/42/25	199404
Construction Costs	203458	253958
Life-Cycle Cost	257916	233330

PROJ2 - ANNUAL ENERGY USE





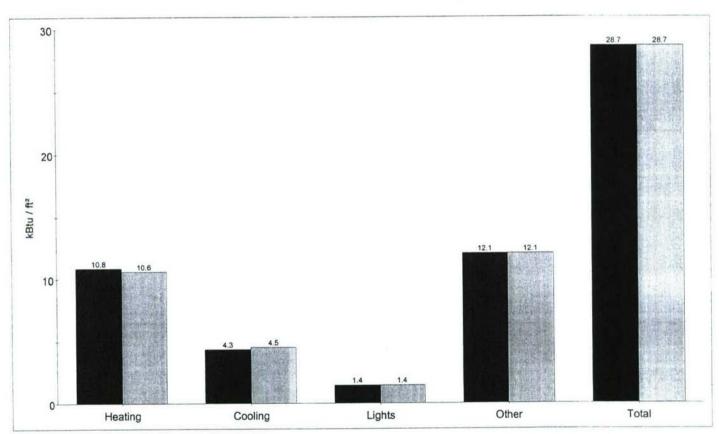
Jul 26, 2004

Project Directory: C:\Program Files\Energy10v1_5\PROJ1

escription:	Gas Furnace Case	12 inch Overhang Case
Scheme Number:	9 / Saved	16 / Saved
Library Name:	PLUMBLEELIB / Saved	PLBLEVARIEDLIB / Saved
Simulation status, Thermal/DL	valid/NA	valid/NA
Comments:	EES by Harry Boody, PE	EES by Harry Boody, PE
Weather file:	Grnsboro.et1	Grnsboro.et1
Floor Area, ft ²	2160.0	2160.0
Surface Area, ft2	5856.5	5856.5
Volume, ft ³	18653.0	18653.0
Total Conduction UA, Btu/h-F	362.4	362.4
_Average U-value, Btu/hr-ft2-F	0.062	0.062
Vall Construction	2 x 4 cypress, R=14.5,etc	2 x 4 cypress, R=14.5,etc
Roof Construction	shingle, attic, r-30, R=30.5	shingle, attic, r-30, R=30.5
Floor type, insulation	Crawl Space, Reff=162.7, etc	Crawl Space, Reff=162.7,etc
Window Construction	2058 double, wood, U=0.48, etc	c2058 double, wood, U=0.48,etc
Window Shading	36 deg lat plumblee, etc	12 inch overhang, etc
Wall total gross area, ft ²	1536	1536
Roof total gross area, ft ²	2160	2160
Ground total gross area, ft2	2160	2160
Window total gross area, ft ²	427	427
Windows (N/E/S/W:Roof)	5/7/13/4:0	5/7/13/4:0
Glazing name	double, U=0.49	double, U=0.49
Classing manie	A STATE OF THE STA	And the desired post material and the second house.
operating parameters for zone	1	
HVAC system DX	Cooling with Gas Furnace DX	Cooling with Gas Furnace
Rated Output (Heat/SCool/TCoo	ol), kBtu/h 38/25/33	38/25/33
		1218/0
Rated Air Flow/MOOA,cfm Heating thermostat Cooling thermostat Heat/cool performance	68.0 °F, no setback	68.0 °F, no setback
Cooling thermostat	77.0 °F, no setup	77.0 °F, no setup
Heat/cool performance	eff=80,EER=10.1	eff=80,EER=10.1
Economizer?/type	no/NA	no/NA
Duct leaks/conduction losses,	total % 11/10	11/10
Peak Gains; IL, EL, HW, OT; W/ft	0.20/0.04/2.08/0.25	0.20/0.04/2.08/0.25
_Added mass?	none	none
Daylighting?	no	no
Infiltration, in ²	ACH=0.2	ACH=0.2
The state of the s		
Results:		
Energy cost 2.020\$/Therm,0	.069\$/kWh,0.000\$/kW 2.020\$/T	Therm, 0.069\$/kWh, 0.000\$/kW
Simulation dates	01-Jan to 31-Dec	
Energy use, kBtu	61933	61889
Energy cost, \$	1251	1250
Saved by daylighting, kWh		NA
Total Electric, kWh	4727	4863
Internal/External lights, kV		915/0
Heating/Cooling/Fan, kWh	0/2744/280	0/2870/289
Hot water/Other, kWh	0/788	0/788
Peak Electric, kW	3.7	3.7
Fuel, hw/heat/total, kBtu	22383/23420/45803	22383/22914/45297
Emissions, CO2/SO2/NOx, 1bs	11763/42/25	11885/43/26
Construction Costs	203458	200517
Life-Cycle Cost	257916	257998

PROJ2 - ANNUAL ENERGY USE

■ Gas Furnace Case ■ 12 inch Overhang Case



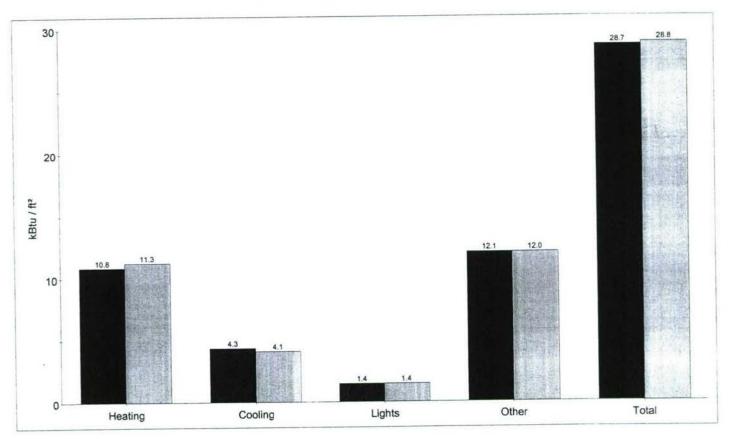
Jul 26, 2004

Project Directory: C:\Program Files\Energy10v1_5\PROJ1

escription:	Gas Furnace Case		
Scheme Number:	9 / Saved		
Library Name:		PLBLEVARIEDLIB / Not Saved	
mimulation status, Thermal/DI	valid/NA	valid/NA	
comments:	EES by Harry Boody, PE	EES by Harry Boody, PE	
Weather file:	Grnsboro.et1	Grnsboro.et1	
Floor Area, ft ²	2160.0	2160.0	
Surface Area, ft ²	5856.5	5856.5	
'olume, ft ³	18653.0	18653.0	
Total Conduction UA, Btu/h-F		362.4	
_Average U-value, Btu/hr-ft2-F	0.062	0.062	
Vall Construction		2 x 4 cypress, R=14.5,etc	
Roof Construction	shingle, attic, r-30, R=30	0.5 shingle, attic, r-30, R=30.5 c Crawl Space, Reff=162.7, etc etc2058 double, wood, U=0.48, et)
Floor type, insulation	Crawl Space, Reff=162.7, et	cc Crawl Space, Reff=162.7, etc	
THOO COMBELLOS	zeec acamer, mean,	s. 	C
Jindow Shading	36 deg lat plumblee,etc		
Wall total gross area, ft2	1536		
Roof total gross area, ft2	2160	2160	
fround total gross area, ft2	2160	2160	
Vindow total gross area, ft2	427	427	
Windows (N/E/S/W:Roof)	5/7/13/4:0	5/7/13/4:0	
Glazing name	double, U=0.49	double, U=0.49	
perating parameters for zone	1		
		DX Cooling with Gas Furnace	
Rated Output (Heat/SCool/TCoo		38/25/33	
Rated Air Flow/MOOA, cfm	1210/0		
Heating thermostat	68.0 °F, no setback		
Cooling thermostat	77.0 °F, no setup		
Heat/cool performance	eff=80,EER=10.1		
Sconomizer?/type	no/NA		
Duct leaks/conduction losses,	total % 11/10		
Peak Gains; IL, EL, HW, OT; W/ft	0.20/0.04/2.08/0.25	0.20/0.04/2.08/0.25	
_Added mass?	none	none	
Daylighting?	no		
Infiltration, in ²	ACH=0.2	ACH=0.2	
The state of the s			
Results:	0.000 (1-121- 0.0000 (1-12- 0.000	c/mha 0 060c/bWh 0 000c/bW	
	.069\$/kWh,0.000\$/kW 2.020	\$/Therm,0.069\$/kWh,0.000\$/kW 01-Jan to 31-Dec	
Simulation dates	01-Jan to 31-Dec	62306	
Energy use, kBtu	61933	1259	
Energy cost, \$	1251		
Saved by daylighting, kWh	- 1707	NA 4573	
Total Electric, kWh	4727	915/0	
Internal/External lights, kV		0/2599/272	
Heating/Cooling/Fan, kWh	0/2744/280		
Hot water/Other, kWh	0/788	0/788	
Peak Electric, kW	3.7		
Fuel, hw/heat/total, kBtu	22383/23420/45803	22383/24318/46701	
Emissions, CO2/SO2/NOx, lbs	11763/42/25		
Construction Costs	203458	200465	
Life-Cycle Cost	257916	258054	

PROJ2 - ANNUAL ENERGY USE



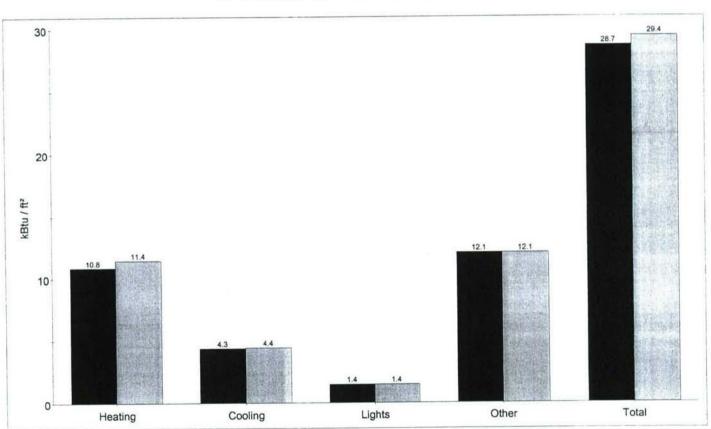


Energy-10 Summary Page Project: PROJ2 Jul 26, 2004 Project Directory: C:\Program Files\Energy10v1_5\PROJ1

Description:	Gas Furnace Case	No Brick Pavers Case
Scheme Number:	9 / Saved	33 / Saved
Library Name:	PLUMBLEELIB / Saved	PLUMBLEELIB / Saved
Bimulation status, Thermal/DL		valid/NA
Comments:	EES by Harry Boody, PE	EES by Harry Boody, PE
Weather file:	Grnsboro.et1	Grnsboro.et1
Floor Area, ft ²	2160.0	2160.0
Surface Area, ft ²	5856.5	5856.5
Volume, ft ³	18653.0	18653.0
Total Conduction UA, Btu/h-F		362.8
_Average U-value, Btu/hr-ft2-F		0.062
Wall Construction	2 x 4 cypress, R=14.5,etc 2	2 x 4 cypress, R=14.5,etc
Wall Construction	shingle, attic, r-30, R=30.5	
	Crawl Space, Reff=162.7, etc	Crawl Space, Reff=132.4
	2050 double wood U-0 40 oto	2058 double, wood, U=0.48,etc
[1] [1] [1] [1] [1] [1] [1] [1] [1] [1]	36 deg lat plumblee, etc	26 des lat plumbles etc
Window Shading		
Wall total gross area, ft ²	1536	1536
Roof total gross area, ft ²	2160	2160
Ground total gross area, ft ²	2160	2160
Window total gross area, ft ²	427	427
Windows (N/E/S/W:Roof)	5/7/13/4:0	5/7/13/4:0
Glazing name	double, U=0.49	double, U=0.49
Operating parameters for zone	i C li iii C - D DV	Carling with Car Europe
	Cooling with Gas Furnace DX	
Rated Output (Heat/SCool/TCoo		38/25/33
Rated Air Flow/MOOA,cfm	1210/0	1221/0
Heating thermostat	68.0 °F, no setback	68.0 °F, no setback
Cooling thermostat	77.0 °F, no setup eff=80,EER=10.1	77.0 °F, no setup
Heat/cool performance		
Economizer?/type	no/NA	no/NA
Duct leaks/conduction losses,	total % 11/10	11/10
Peak Gains; IL, EL, HW, OT; W/ft	0.20/0.04/2.08/0.25	0.20/0.04/2.08/0.25
_Added mass?	none	none
Daylighting?	no	no
Infiltration, in ²	ACH=0.2	ACH=0.2
Results:	0.500 (1111 0 0000 (1111 0 0000 (III	h 0 0606 (l-tilb 0 0006 (l-til
	.069\$/kWh,0.000\$/kW 2.020\$/T	0.4 - 0.4 -
Simulation dates		01-Jan to 31-Dec 63481
Energy use, kBtu	61933	
Energy cost, \$	1251	1283
Saved by daylighting, kWh	-	NA
Total Electric, kWh	4727	4801
Internal/External lights, kw		915/0
■ Heating/Cooling/Fan, kWh	0/2744/280	0/2807/292
Hot water/Other, kWh	0/788	0/788
Peak Electric, kW	3.7	3.7
Fuel, hw/heat/total, kBtu	22383/23420/45803	22383/24715/47098
Emissions, CO2/SO2/NOx, lbs	11763/42/25	12015/43/26
Construction Costs	203458	200547
Life-Cycle Cost	257916	258932
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PROJ2 - ANNUAL ENERGY USE





Jul 26, 2004

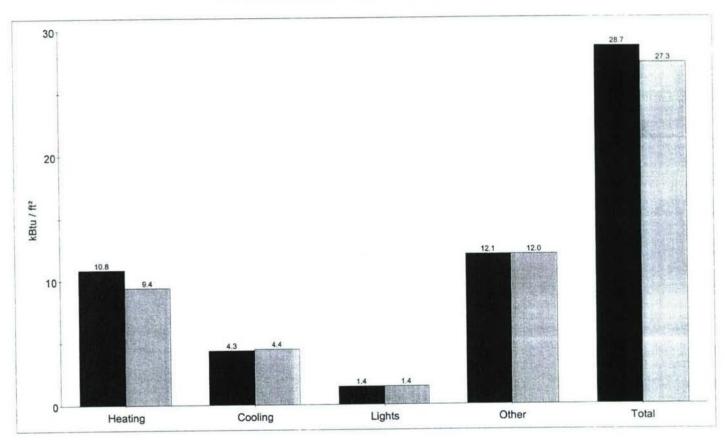
Project Directory: C:\Program Files\Energy10v1_5\PROJ1 Energy-10 Summary Page Project: PROJ2

_		
Description:	Gas Furnace Case	Exterior Walls 2x6 Case
Scheme Number:	9 / Saved	34 / Saved
Library Name:	obsolete / Not Saved	PLUMBLEELIB / Saved
Simulation status, Thermal/DL	valid/NA	valid/NA
Comments:	EES by Harry Boody, PE	EES by Harry Boody, PE
Weather file:	Grnsboro.et1	Grnsboro.et1
Floor Area, ft ²	2160.0	2160.0
Surface Area, ft ²	5856.5	5856.5
Volume, ft ³	18653.0	18653.0
Total Conduction UA, Btu/h-F	362.4	339.3
_Average U-value, Btu/hr-ft2-F	0.062	0.058
Wall Construction	2 x 4 cypress, R=14.5,etc	2 x 6 cypress, R=19.8,etc
Roof Construction	shingle, attic, r-30, R=30.	.5 shingle, attic, r-30, R=30.5
	Crawl Space, Reff=162.7,etc	
_Window Construction	2058 double, wood, U=0.48.6	etc2058 double, wood, U=0.48,etc
Window Shading	36 deg lat plumblee, etc	36 deg lat plumblee, etc
Wall total gross area, ft ²	1536	1536
Roof total gross area, ft ²	2160	2160
Ground total gross area, ft ²	2160	2160
Window total gross area, ft ²	427	427
Windows (N/E/S/W:Roof)	5/7/13/4:0	5/7/13/4:0
Glazing name	double, U=0.49	double, U=0.49
Grazing name	dodb10, 0 0.13	
Operating parameters for zone	1.	
HVAC system DX	Cooling with Gas Furnace	DX Cooling with Gas Furnace
Rated Output (Heat/SCool/TCoo		36/24/32
Rated Air Flow/MOOA, cfm	1210/0	1187/0
Heating thermostat	68.0 °F, no setback	68.0 °F, no setback
Cooling thermostat	77.0 °F, no setup	77.0 °F, no setup
Heat/cool performance	eff=80,EER=10.1	eff=80, EER=10.1
Economizer?/type	no/NA	no/NA
Duct leaks/conduction losses,		11/10
Peak Gains; IL, EL, HW, OT; W/ft	2 0 20/0 04/2 08/0 25	0.20/0.04/2.08/0.25
_Added mass?	none	none
	no	no
Daylighting? Infiltration, in ²	ACH=0.2	ACH=0.2
Initiciación, in	11011 0.2	
-Results:		
Energy cost 2.020\$/Therm,0	0695/kWh.0.000\$/kW 2.020\$	7Therm, 0.069\$/kWh, 0.000\$/kW
Simulation dates	01-Jan to 31-Dec	01-Jan to 31-Dec
THE STATE OF THE PROPERTY OF T	61933	59019
Energy use, kBtu Energy cost, \$	1251	1192
Saved by daylighting, kWh	-	NA
Total Electric, kWh	4727	4796
Internal/External lights, kW		915/0
■ Heating/Cooling/Fan, kWh	0/2744/280	0/2816/277
Hot water/Other, kWh	0/788	0/788
Peak Electric, kW	3.7	3.7
Fuel, hw/heat/total, kBtu	22383/23420/45803	22383/20270/42653
Emissions, CO2/SO2/NOx, 1bs	11763/42/25	11483/43/25
Construction Costs	203458	200187
Life-Cycle Cost	257916	255790
TITE OFFICE OFFI		

Life-Cycle Cost

PROJ2 - ANNUAL ENERGY USE





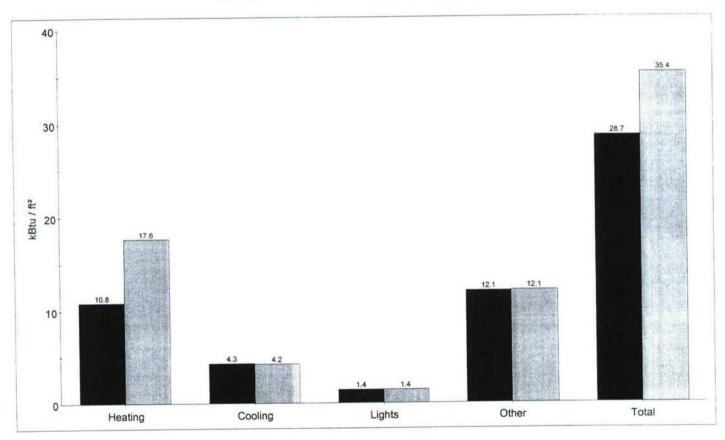
Jul 26, 2004

Project Directory: C:\Program Files\Energy10v1_5\PROJ1 nergy-10 Summary Page Project: PROJ2

escription:	Gas Furnace Case		ion 0.5 ACH Case
Scheme Number:	9 / Saved		20 / Saved
Library Name:	PLUMBLEELIB / Saved		MBLEELIB / Saved
Simulation status, Thermal/DL	valid/NA		valid/NA
Comments:	EES by Harry Boody, PE	EES by	Harry Boody, PE
Weather file:	Grnsboro.et1		Grnsboro.et1
Floor Area, ft ²	2160.0		2160.0
Surface Area, ft ²	5856.5		5856.5
Volume, ft ³	18653.0		18653.0
Total Conduction UA, Btu/h-F	362.4		362.4
_Average U-value, Btu/hr-ft2-F	0.062	A LOSS CALL RECEIVE	0.062
Wall Construction	2 x 4 cypress, R=14.5,etc		press, R=14.5,etc
Roof Construction	shingle, attic, r-30, R=30		attic, r-30, R=30.5
Floor type, insulation	Crawl Space, Reff=162.7, et		pace, Reff=162.7,etc
-Window Construction	2058 double, wood, U=0.48,		ible, wood, U=U.48,etc
Window Shading	36 deg lat plumblee, etc	36 deg	lat plumblee,etc
Wall total gross area, ft ²	1536		1536
Roof total gross area, ft2	2160		2160 2160
Ground total gross area, ft2	2160		
Window total gross area, ft ²	427		427 5/7/13/4:0
Windows (N/E/S/W:Roof)	5/7/13/4:0		double, U=0.49
Glazing name	double, U=0.49		double, 0=0.49
Operating parameters for zone		DV Caalina	with Cas Europas
	Cooling with Gas Furnace	DX Cooling	46/28/37
Rated Output (Heat/SCool/TCoo			1287/0
Rated Air Flow/MOOA,cfm	1210/0	60	.0 °F, no setback
deating thermostat	68.0 °F, no setback		77.0 °F, no setup
Cooling thermostat	77.0 °F, no setup eff=80, EER=10.1		eff=80,EER=10.1
Heat/cool performance	no/NA		no/NA
Economizer?/type Duct leaks/conduction losses,			11/10
Peak Gains; IL, EL, HW, OT; W/ft	2 0 20/0 04/2 08/0 25	0 :	20/0.04/2.08/0.25
	none		none
Added mass?	no		no
Daylighting?	ACH=0.2		ACH=0.5
Infiltration, in ²	ACH-U.Z		Acii-0.5
Results:		* /=: 0 0	COA (1171 - O. 0000 (117
Energy cost 2.020\$/Therm,0	.069\$/kWh,0.000\$/kW 2.020	\$/Therm, 0.0	69\$/ KWN, U. UUU\$/ KW
Simulation dates	01-Jan to 31-Dec		01-Jan to 31-Dec 76381
Energy use, kBtu	61933		
Energy cost, \$	1251		1543
Saved by daylighting, kWh	4707		NA 4666
Total Electric, kWh	4727		915/0
Internal/External lights, k	Vh 915/0		0/2664/299
Heating/Cooling/Fan, kWh	0/2744/280		0/2664/299
Hot water/Other, kWh	0/788		4.2
Peak Electric, kW	3.7		22383/38078/60461
Fuel, hw/heat/total, kBtu	22383/23420/45803		13411/44/27
Emissions, CO2/SO2/NOx, lbs	11763/42/25 203458		201844
Construction Costs	3 THE RESERVE OF THE		268556
Life-Cycle Cost	257916		200330
155m			

PROJ2 - ANNUAL ENERGY USE

■ Gas Furnace Case Infiltration 0.5 ACH Case



Life-Cycle Cost

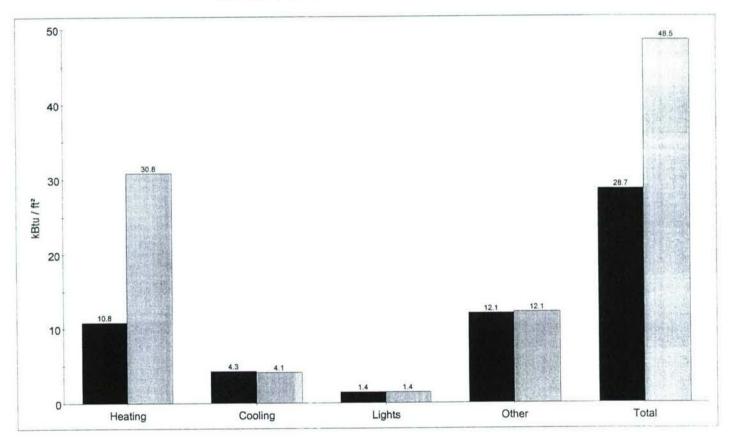
Jul 26, 2004

Project Directory: C:\Program Files\Energy10v1_5\PROJ1

Description:	Gas Furnace Case	Infiltration 1.0 ACH Case
Scheme Number:	9 / Saved	21 / Saved
Library Name:	PLUMBLEELIB / Saved	PLUMBLEELIB / Saved
Simulation status, Thermal/DL	valid/NA	valid/NA
Comments:	EES by Harry Boody, PE	EES by Harry Boody, PE
Weather file:	Grnsboro.et1	Grnsboro.et1
Floor Area, ft ²	2160.0	2160.0
Surface Area, ft ²	5856.5	5856.5
Volume, ft ³	18653.0	18653.0
Total Conduction UA, Btu/h-F	362.4	362.4
_Average U-value, Btu/hr-ft2-F	0.062	0.062
Wall Construction	2 x 4 cypress, R=14.5,etc	2 x 4 cypress, R=14.5,etc
Roof Construction	shingle, attic, r-30, R=30.	5 shingle, attic, $r-30$, $R=30.5$
Floor type, insulation	Crawl Space, Reff=162.7, etc	Crawl Space, Reff=162.7,etc
-Window Construction	2058 double, wood, U=0.48,e	tc2058 double, wood, U=0.48,etc
Window Shading	36 deg lat plumblee, etc	36 deg lat plumblee, etc
Wall total gross area, ft ²	1536	1536
Roof total gross area, ft ²	2160	2160
Ground total gross area, ft ²	2160	2160
Window total gross area, ft ²	427	427
Windows (N/E/S/W:Roof)	5/7/13/4:0	5/7/13/4:0
Glazing name	double, U=0.49	double, U=0.49
Grazing name	doubte, o o	Control of the Contro
Operating parameters for zone	1	
HVAC system DX	Cooling with Gas Furnace I	OX Cooling with Gas Furnace
Rated Output (Heat/SCool/TCoo		59/32/43
Rated Air Flow/MOOA, cfm	1210/0	1417/0
Heating thermostat	68.0 °F, no setback	68.0 °F, no setback
Cooling thermostat	77.0 °F, no setup	77.0 °F, no setup
_Heat/cool performance	eff=80,EER=10.1	
Economizer?/type	no/NA	no/NA
Duct leaks/conduction losses,	200 mg/200 gg 100 g	11/10
Peak Gains; IL, EL, HW, OT; W/ft	2 0 20/0 04/2 08/0 25	0.20/0.04/2.08/0.25
_Added mass?	none	none
Daylighting?	no	no
Infiltration, in ²	ACH=0.2	ACH=1.0
miniticiación, in	11011 0.2	
Results:		
Energy cost 2.020\$/Therm,0	.069s/kWh.0.000s/kW 2.020\$	/Therm, 0.069\$/kWh, 0.000\$/kW
Simulation dates	01-Jan to 31-Dec	01-Jan to 31-Dec
Energy use, kBtu	61933	104793
Energy cost, \$	1251	2117
Saved by daylighting, kWh		NA
Total Electric, kWh	4727	4653
Internal/External lights, kW		915/0
Heating/Cooling/Fan, kWh	0/2744/280	0/2610/340
	0/788	0/788
Hot water/Other, kWh	3.7	4.9
Peak Electric, kW	22383/23420/45803	22383/66534/88916
Fuel, hw/heat/total, kBtu		16754/47/31
Emissions, CO2/SO2/NOx, 1bs	11763/42/25	204221
Construction Costs	203458	288936
Life-Cycle Cost	257916	200930

PROJ2 - ANNUAL ENERGY USE





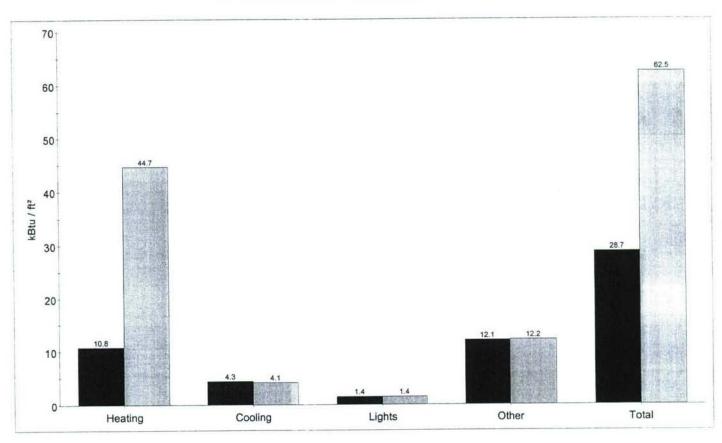
Jul 26, 2004

Project Directory: C:\Program Files\Energy10v1_5\PROJ1

escription:	Gas Furnace Case	Infiltration 1.5 ACH Case
Scheme Number:	9 / Saved	22 / Saved
Library Name:	PLUMBLEELIB / Saved	PLUMBLEELIB / Saved
mimulation status, Thermal/DI		valid/NA
comments:	EES by Harry Boody, PE	EES by Harry Boody, PE
Weather file:	Grnsboro.etl	Grnsboro.et1
Floor Area, ft ²	2160.0	2160.0
	5856.5	5856.5
Surface Area, ft ²	18653.0	18653.0
Yolume, ft ³ Total Conduction UA, Btu/h-F	362.4	362.4
		0.062
Average U-value, Btu/hr-ft2-F	2 x 4 cypress, R=14.5,etc	2 x 4 cypress, R=14.5,etc
Wall Construction	chingle attic r-30 R=30	5 shingle, attic, r-30, R=30.5
koof Construction	Crawl Space, Reff=162.7, etc	
Floor type, insulation	2050 double wood II=0 48 e	tc2058 double, wood, U=0.48,etc
Window Construction	36 deg lat plumblee,etc	36 deg lat plumblee, etc
Window Shading Wall total gross area, ft ² Roof total gross area, ft ²	1536	1536
Wall total gross area, it'	2160	2160
Root cotal gross area, re	2160	2160
Ground total gross area, ft ²	427	427
Vindow total gross area, ft ²	5/7/13/4:0	5/7/13/4:0
Windows (N/E/S/W:Roof)	double, U=0.49	double, U=0.49
Glazing name	double, 0-0.49	double, 0-0.45
Operating parameters for zone	. 1	
AVAC system Di	K Cooling with Gas Furnace I	OX Cooling with Gas Furnace
Rated Output (Heat/SCool/TCool	38/25/33	73/37/49
	1210/0	1560/0
Rated Air Flow/MOOA,cfm	68.0 °F, no setback	2/2/
Heating thermostat	77.0 °F, no setup	77.0 °F, no setup
Cooling thermostat	eff=80, EER=10.1	eff=80,EER=10.1
Heat/cool performance	no/NA	no/NA
Economizer?/type		11/10
Duct leaks/conduction losses,	2 0 20/0 04/2 08/0 25	0.20/0.04/2.08/0.25
Peak Gains; IL, EL, HW, OT; W/ft	none	none
Added mass?	no	no
Daylighting?	ACH=0.2	ACH=1.5
Infiltration, in ²	Acti-0.2	11011 110
_Results:		
Energy cost 2.020\$/Therm,0	0695/kWh 0 0005/kW 2.0205	/Therm, 0.069\$/kWh, 0.000\$/kW
Simulation dates	01-Jan to 31-Dec	01-Jan to 31-Dec
Energy use, kBtu	61933	135009
Energy cost, \$	1251	2727
Saved by daylighting, kWh	_	NA
Total Electric, kWh	4727	4702
Internal/External lights, ki		915/0
■ Heating/Cooling/Fan, kWh	0/2744/280	0/2613/386
Hot water/Other, kWh	0/788	0/788
Peak Electric, kW	3.7	5.6
Fuel, hw/heat/total, kBtu	22383/23420/45803	22383/96583/118965
Emissions, CO2/SO2/NOx, lbs	11763/42/25	20369/50/35
Construction Costs	203458	206580
Life-Cycle Cost	257916	310302
Tite Cycle cost		

PROJ2 - ANNUAL ENERGY USE

Gas Furnace Case Infiltration 1.5 ACH Case



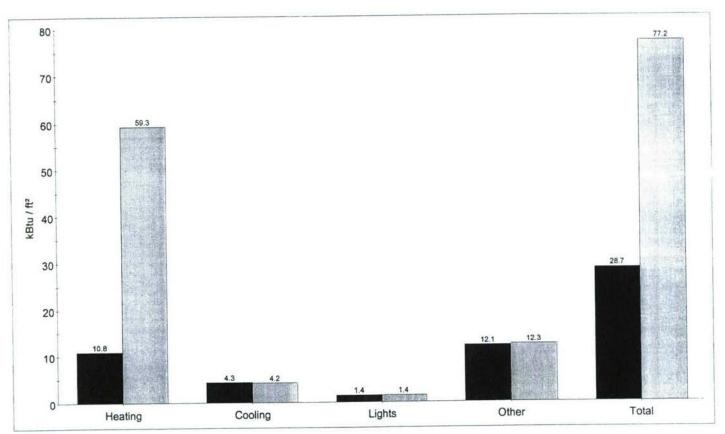
Jul 26, 2004

Project Directory: C:\Program Files\Energy10v1_5\PROJ1 nergy-10 Summary Page Project: PROJ2

escription:	Gas Furnace Case	Infiltration 2.0 ACH Case	
cheme Number:	9 / Saved	23 / Saved	
Library Name:	PLUMBLEELIB / Saved	PLUMBLEELIB / Saved	
Simulation status, Thermal/DL	valid/NA	valid/NA	
comments:	EES by Harry Boody, PE	EES by Harry Boody, PE	
Weather file:	Grnsboro.et1	Grnsboro.et1	
Floor Area, ft ²	2160.0	2160.0	
Surface Area, ft ²	5856.5	5856.5	
	18653.0	18653.0	
Volume, ft ³	362.4	362.4	
Total Conduction UA, Btu/h-F	0.062	0.062	
Average U-value, Btu/hr-ft2-F		2 x 4 cypress, R=14.5,etc	
	x 4 cypress, R=14.5,etc	5 shingle, attic, r-30, R=30.5	
	shingle, attic, r-30, R=30.	Sningle, accic, 1-30, K-30.	1
	Crawl Space, Reff=162.7,etc	Crawl Space, Reff=162.7,etc	
		tc2058 double, wood, U=0.48,et	. C
Vindow Shading	36 deg lat plumblee, etc	36 deg lat plumblee,etc	
Wall total gross area, ft ²	1536	1536	
Roof total gross area, ft2	2160	2160	
Ground total gross area, ft2	2160	2160	
Window total gross area, ft ²	427	427	
Windows (N/E/S/W:Roof)	5/7/13/4:0	5/7/13/4:0	
Glazing name	double, U=0.49	double, U=0.49	
_			
Operating parameters for zone	1		
HVAC system DX	Cooling with Gas Furnace I	OX Cooling with Gas Furnace	
Rated Output (Heat/SCool/TCool), kBtu/h 38/25/33	88/41/55	
Rated Air Flow/MOOA, cfm	1210/0	1778/0	
Heating thermostat	68.0 °F, no setback	68.0 °F, no setback	
Cooling thermostat	77.0 °F, no setup		
Heat/cool performance			
Economizer?/type	no/NA		
Ouct leaks/conduction losses,		11/10	
Peak Gains; IL, EL, HW, OT; W/ft2	0 20/0 04/2 08/0 25		
Peak Gains; IL, EL, HW, OI; W/IC	none	none	
Added mass?	no	no	
Daylighting?	ACH=0.2	ACH=2.0	
Infiltration, in ²	ACH=0.2	ACH-2.0	
D 1 h			
Results: Energy cost 2.020\$/Therm, 0.	0606/FMP 0 0006/FM 2 0205	/Therm 0 0698/kWh.0 0008/kW	
	01-Jan to 31-Dec	01-Jan to 31-Dec	
Simulation dates	61933	166753	
Energy use, kBtu		3369	
Energy cost, \$	1251		
Saved by daylighting, kWh	-	NA 4703	
Total Electric, kWh	4727	4793	
Internal/External lights, kWh	915/0	915/0	
Heating/Cooling/Fan, kWh	0/2744/280	0/2636/454	
Hot water/Other, kWh	0/788	0/788	
Peak Electric, kW	3.7	6.2	
Fuel, hw/heat/total, kBtu	22383/23420/45803	22383/128014/150397	
Emissions, CO2/SO2/NOx, 1bs	11763/42/25	24204/54/39	
Construction Costs	203458	209245	
Life-Cycle Cost	257916	333136	
Tite-cycle cosc			

PROJ2 - ANNUAL ENERGY USE

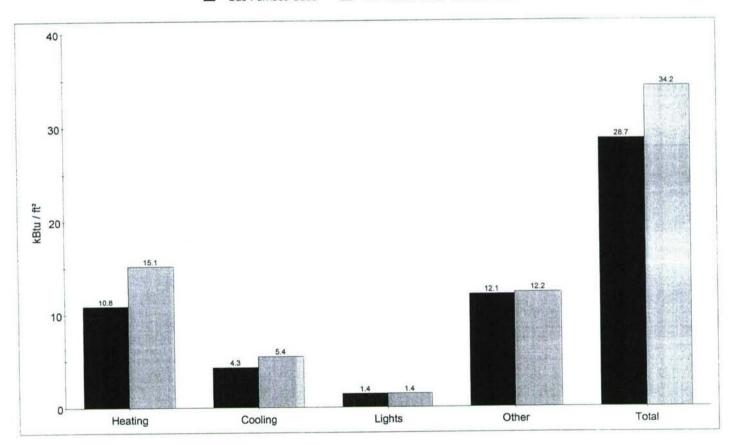




Jul 26, 2004 nergy-10 Summary Page Project: PROJ2 Project Directory: C:\Program Files\Energy10v1_5\PROJ1

escription:	Gas Furnace Case	70F Winter &	75F Summer Case
Scheme Number:	9 / Saved		24 / Saved
Library Name:	PLUMBLEELIB / Saved	PLUM	BLEELIB / Saved
Simulation status, Thermal/DL	valid/NA		valid/NA
Comments:	EES by Harry Boody, PE	EES by	Harry Boody, PE
Weather file:	Grnsboro.et1		Grnsboro.et1
Floor Area, ft ²	2160.0		2160.0
Surface Area, ft ²	5856.5		5856.5
Volume, ft ³	18653.0		18653.0
Total Conduction UA, Btu/h-F	362.4		362.4
Average U-value, Btu/hr-ft2-F			0.062
	2 x 4 cypress, R=14.5, etc	2 x 4 cvpr	ess, R=14.5,etc
의 중점 (프로그램) 전 경기 하면 (Color) 등에 열린 (Color) (Color) 등을 보고 있다.	shingle, attic, r-30, R=30	5 shingle.	attic. r-30. R=30.5
	Crawl Space, Reff=162.7, et	c Crawl Spa	ce. Reff=162.7.etc
	2058 double, wood, U=0.48,	etc2058 doub	le wood []=0 48.etc
	36 deg lat plumblee, etc	36 deg 1	at plumblee, etc
Window Shading	1536	Jo deg 1	1536
Wall total gross area, ft ²	2160		2160
Roof total gross area, ft ²			2160
Ground total gross area, ft ²	2160		427
Window total gross area, ft ²	427		5/7/13/4:0
Windows (N/E/S/W:Roof)	5/7/13/4:0		
Glazing name	double, U=0.49		double, U=0.49
Rated Output (Heat/SCool/TCool Rated Air Flow/MOOA, cfm Heating thermostat Cooling thermostat Heat/cool performance Economizer?/type Duct leaks/conduction losses, Peak Gains; IL, EL, HW, OT; W/ft Added mass? Daylighting? Infiltration, in2	<pre>K Cooling with Gas Furnace 38/25/33 1210/0 68.0 °F, no setback 77.0 °F, no setup eff=80, EER=10.1 no/NA total % 11/10</pre>	70.0 75	with Gas Furnace 41/26/35 1416/0 0 °F, no setback 0.0 °F, no setup eff=80,EER=10.1 no/NA 11/10 0/0.04/2.08/0.25 none no ACH=0.2
Results:		. (=) 0.00	00 (1121 0 0000 (112
Energy cost 2.020\$/Therm,0	.069\$/kWh,0.000\$/kW 2.020	\$/Therm, 0.069	9\$/kwh,0.000\$/kw
Simulation dates	01-Jan to 31-Dec	į,)1-Jan to 31-Dec
Energy use, kBtu	61933		73980
_Energy cost, \$	1251		1495
Saved by daylighting, kWh			NA
Total Electric, kWh	4727		5546
Internal/External lights, kV	Wh 915/0		915/0
- Heating/Cooling/Fan, kWh	0/2744/280		0/3438/405
Hot water/Other, kWh	0/788		0/788
Peak Electric, kW	3.7	23	4.0
Fuel, hw/heat/total, kBtu	22383/23420/45803	2:	2383/32673/55056
Emissions, CO2/SO2/NOx, lbs	11763/42/25		13956/50/30
Construction Costs	203458		201592
Life-Cycle Cost	257916		266986

PROJ2 - ANNUAL ENERGY USE



Inergy-10 Summary Page
Project: PROJ2
Project Directory: C:\Program Files\Energy10v1_5\PROJ1

escription:	Gas Furnace Case 72F Wint	er & 73F Summer Case
cheme Number:	9 / Saved	29 / Saved
Library Name:	PLUMBLEELIB / Saved	PLUMBLEELIB / Saved
Simulation status, Thermal/DL	valid/NA	valid/NA
Comments:	EES by Harry Boody, PE EES	by Harry Boody, PE
Weather file:	Grnsboro.et1	Grnsboro.et1
Floor Area, ft ²	2160.0	2160.0
Floor Area, it	5856.5	5856.5
Surface Area, ft ²	18653.0	18653.0
Volume, ft ³	362.4	362.4
Total Conduction UA, Btu/h-F	0.062	0.062
Average U-value, Btu/hr-ft2-F	137	cypress, R=14.5,etc
	x 4 cypress, R=14.5, etc 2 x 4 shingle, attic, r-30, R=30.5 shing	rle attic r-30. R=30.5
	Crawl Space, Reff=162.7, etc Crawl	Space Reff=162 7 etc
	Crawl Space, ReII=162.7, etc Claw-	double wood H=0 48 etc
	2058 double, wood, U=0.48, etc2058	deg lat plumblee, etc
Window Shading	50 dog === [1536
Vall total gross area, ft ²	1536	
Roof total gross area, ft2	2160	2160
Ground total gross area, ft2	2160	2160
Vindow total gross area, ft ²	427	427
Windows (N/E/S/W:Roof)	5/7/13/4:0	5/7/13/4:0
Glazing name	double, U=0.49	double, U=0.49
_		
Operating parameters for zone	1	S. T. S.
HVAC system DX	Cooling with Gas Furnace DX Cool	ing with Gas Furnace
Rated Output (Heat/SCool/TCool),kBtu/h 38/25/33	44/28/37
Rated Air Flow/MOOA, cfm	1210/0	1674/0
Heating thermostat	68.0 °F, no setback	72.0 °F, no setback
Cooling thermostat	77.0 °F, no setup	73.0 °F, no setup
Heat/cool performance	eff=80, EER=10.1	eff=80,EER=10.1
Economizer?/type	no/NA	no/NA
Duct leaks/conduction losses.	total % 11/10	11/10
Peak Gains; IL, EL, HW, OT; W/ft	0.20/0.04/2.08/0.25	0.20/0.04/2.08/0.25
Added mass?	none	none
Daylighting?	no	no
Infiltration, in ²	ACH=0.2	ACH=0.2
inilitiation, in		
Results:		
Results.	069\$/kWh,0.000\$/kW 2.020\$/Therm,	0.069\$/kWh,0.000\$/kW
	01-Jan to 31-Dec	01-Jan to 31-Dec
Simulation dates	61933	96174
Energy use, kBtu	1251	1943
Energy cost, \$	_	NA
Saved by daylighting, kWh	4727	6815
Total Electric, kWh		915/0
Internal/External lights, kW	0/2744/280	0/4482/630
Heating/Cooling/Fan, kWh	0/2/44/200	0/788
Hot water/Other, kWh	3.7	4.2
Peak Electric, kW	22383/23420/45803	22383/50536/72919
Fuel, hw/heat/total, kBtu		17771/62/37
Emissions, CO2/SO2/NOx, lbs	11763/42/25	202916
Construction Costs	203458	282253

257916

282253

Construction Costs

PROJ2 - ANNUAL ENERGY USE



